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AIRCRAFT MIG-21FL

TECHNICAL DESCRIPTION

BOOK III

CONSTRUCTION

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AIRCRAFT МиГ-21ФЛ

BOOK III

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AIRCRAFT МиГ-21ФЛ

TECHNICAL DESCRIPTION

BOOK III

CONSTRUCTION

This Technical Description of the aircraft comprises five books:

Book I - Performance Characteristics
Book II - Armament
Book III - Construction
Book IV - Electrical and Oxygen Equipment and Flight Instruments
Book V - Radio Equipment

In servicing the aircraft follow the diagrams as well as the Operating and Maintenance Instructions provided with each aircraft.

The book includes 384 pages.

Besides, there are 17 secret insets: inset 1 to face page 6, insets 2 and 3 to face page 10, inset 4 to face page 26, inset 5 to face page 36, insets 6 and 7 to face page 64, inset 8 to face page 106, inset 9 to face page 142, inset 10 to face page 144, insets 11 and 12 to face page 176, inset 13 to face page 240, inset 14 to face page 262; inset 15 to face page 306, inset 16 to face page 334 and inset 17 to face page 336.

Chapter I

GENERAL

Aircraft МиГ-21ФЛ is a single-seat light fighter with one turbojet engine fitted with up-to-date instruments and radio equipment to make its flights reliable in rough weather in the daytime and at night.

The fighter is an all-metal cantilever centre plane with a thin triangle wing, a sweepback tail unit and a controlled stabilizer.

The air intake has an automatically controlled movable cone to ensure maximum aircraft thrust at minimum drag losses of the air intake.

The air intake duct is provided with shutters decreasing thrust losses when taking off and with anti-surge shutters ensuring reliable engine operation when connecting the afterburner and in the case of maximum angles of attack of the aircraft.

Three air brakes are fitted at the fuselage bottom. The ailerons have axial aerodynamic balance and floating flap 5.

The fuel system includes six tanks inside the fuselage, one saddle tank, four wing tank compartments and one drop tank.

The aircraft is fitted with fire-fighting equipment.

To shorten the landing roll the aircraft is provided with a drag chute located in the tail section of the fuselage.

Longitudinal control of the aircraft is effected by a stabilizer driven by a two-chamber booster.

Transmission ratios from the control stick to the spring-feel mechanism and stabilizer booster are automatically varied in speed and altitude to maintain constant performance characteristics and to eliminate the excessive effect of the stabilizer at high speeds and low altitudes of flight.

Lateral control of the aircraft is effected by the ailerons driven by two boosters. To eliminate the excessive aileron effect at high speeds and low altitudes of flight there is mounted a control stick-to-aileron booster gear ratio non-linear change mechanism.

The lateral control system comprises a single-axis (roll) automatic pilot to ensure:

(a) damping of aircraft roll during manual control;

(b) zeroing of any initial roll angles;

(c) balancing of roll angles.

Rudder control is boosterless. The hydraulic system consists of two independent systems - the booster system and the main system.

The booster hydraulic system feeds the aircraft control system, i.e. it actuates two aileron boosters and one stabilizer booster chamber.

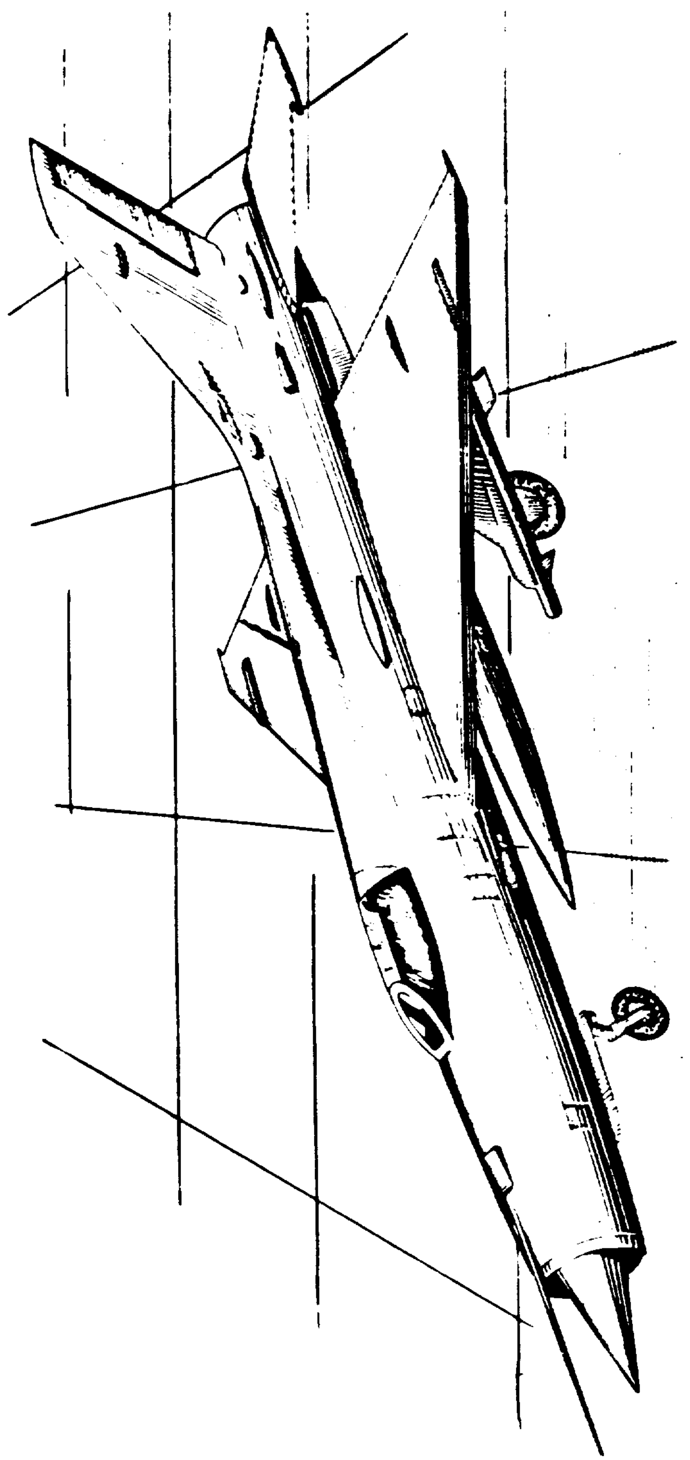

FIG.1. GENERAL VIEW OF AIRCRAFT

The main hydraulic system actuates: the landing gear, flaps, air brakes, anti-surge shutters, air intake movable cone, engine adjustable jet nozzle, automatic pilot (pressure blocking in the hydraulic system), one chamber of the stabilizer booster; this hydraulic system provides for operation of aileron boosters in case of failure of the first hydraulic system and brakes the landing gear wheels automatically during retraction.

If one of the hydraulic systems fails, the power developed by the remaining booster chamber proves sufficient to accomplish the flight. If the engine stops and fails to be started during the flight, the engine autorotations being normal, the aircraft landing is ensured by the pressure created by the hydraulic pumps operating on autorotations and by an emergency pumping unit.

The air system comprises two independent systems: the main and the emergency.

The main system provides for wheel braking, lifting and pressurization of the cockpit canopy, releasing and dropping of the drag chute, emergency tossing and opening of the canopy time delay lock, operation of the de-icer and control of the cooling valve of the forward fuselage hermetic compartments.

The emergency system is designed for landing gear emergency extension and emergency braking of the main wheels.

The pressurized cockpit is supercharged and ventilated automatically to keep normal pressure and temperature conditions.

The cockpit is fitted with oxygen supply system comprising aircraft equipment and an anti-g suit.

The aircraft is equipped with an ejection seat with canopy protection allowing the pilot to safely abandon the aircraft in case of emergency.

The cockpit canopy is fitted with a fluid de-icer.

A generator-starter serves as a D.C. power source.

Two storage batteries operating in parallel with the generator are an auxiliary source of power.

The generator-starter serves for starting the engine. Autonomous engine starting is performed by the storage batteries.

An A.C. generator is an A.C. power source.

Chapter II

AIRFRAME CONSTRUCTION

General

This aircraft is an all-metal centre plane with triangle wings, a controlled stabilizer and a standard vertical tail unit.

The aircraft has a number of structural joints (Fig.2) dividing the fuselage into separate sections: nose section, tail section, wings, stabilizer, rudder, etc. These joints make it possible to replace the engine, and to carry out different operations of routine maintenance.

The fuselage is of a semi-monocoque structure.

Installed in the nose fuselage section at the engine inlet duct is a movable cone with a follow-up control system and a boundary layer bleed device. The cone is made radio transparent. The air intake is bifurcated before the cockpit into two ducts bending round the cockpit and joining again to supply air to the engine. To avoid surging of the engine there are automatically controlled anti-surge shutters on the fuselage. Besides, on the fuselage sides near frames Nos 9-11 additional air intake shutters (take-off shutters) are provided. The two types of shutters serve to associate the air intake with the surrounding atmosphere under different operating conditions. The fuselage mounts three air brakes: two front and one rear.

Installed inside the cockpit are brackets with rollers to mount an ejection seat, type CK, which allows the pilot to abandon the aircraft in case of emergency in the air.

The streamlined cockpit canopy offers the pilot a good field of view.

The superstructure behind the cockpit ensures a smooth transition from the movable section of the canopy to the saddle fuel tank installed on the fuselage behind the cockpit. The non-pressurized superstructure is movable and is secured to the pressurized cockpit partition and fuselage by means of anchor nuts. The pressurized partition separates the airtight cockpit from the non-pressurized superstructure and is fastened in its central part by two braces. The pressurized partition which is a flat sheet with stamped-out beads and riveted shapes, is attached to the canopy-carrying panel, superstructure and frame No.11 by means of rivets and bolts.

Installed in the upper section of the fuselage on the air intake is a pitot-static tube boom.

To guard the pilot in catapulting, the aircraft is fitted with armor elements including an armor shield and armor plates mounted in the upper part of frames Nos [illegible] and 11.

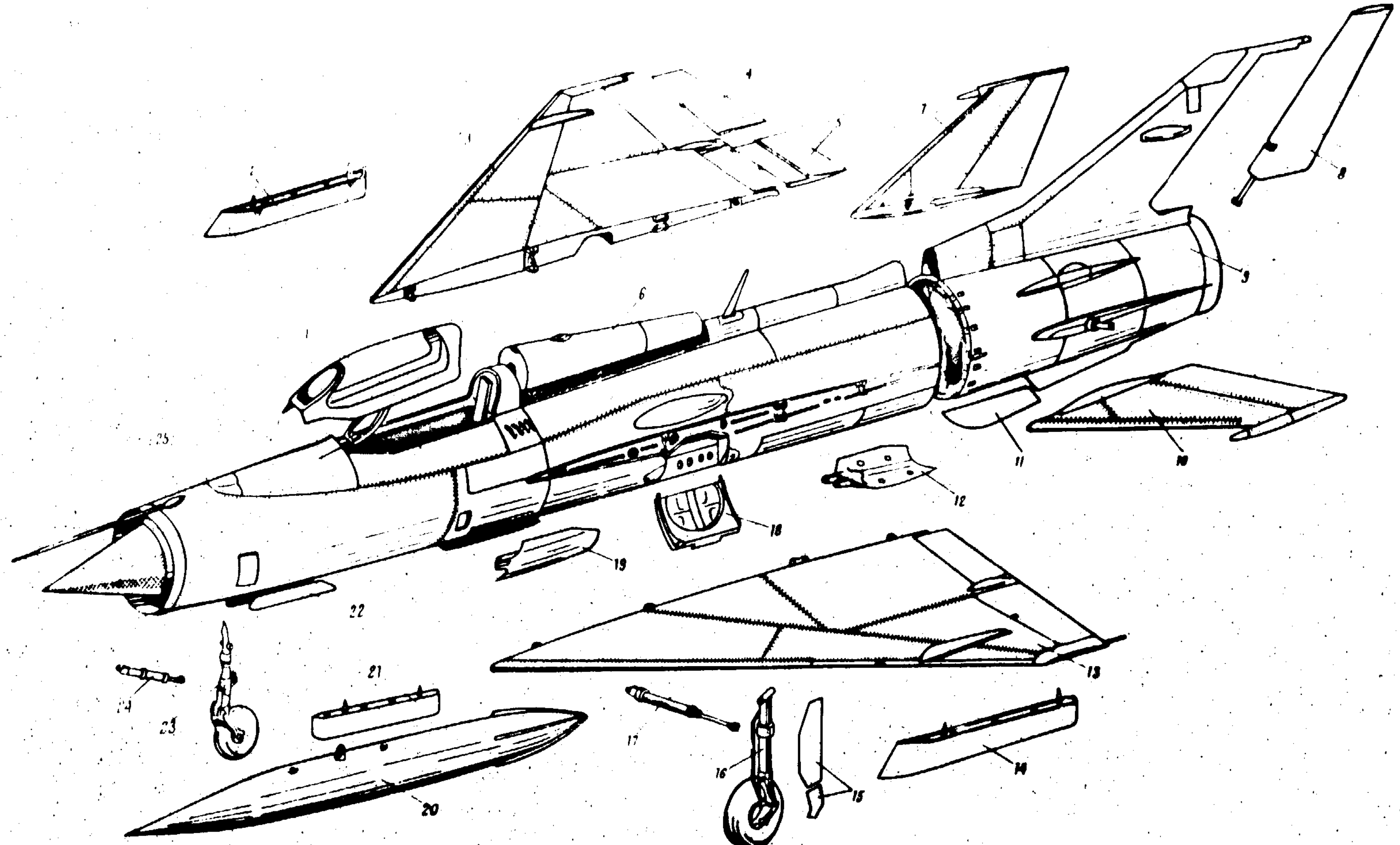

FIG. 2. AIRCRAFT STRUCTURAL JOINTS

1 – canopy; 2 – right pylon; 3 – wing (right outer panel); 4 – aileron; 5 – flap; 6 – tank No.7 (saddle-type); 7 – stabilizer (right half); 8 – rudder; 9 – fuselage tail section; 10 – stabilizer (left half); 11 – fin removable portion; 12 – rear air brake; 13 – wing (left outer panel); 14 – left pylon; 15 – L.G. main wheel strut doors; 16 – L.G. main wheel strut; 17 – main strut actuating cylinder; 18 – main strut door; 19 – front air brake; 20 – drop tank; 21 – pylon; 22 – L.G. nose strut doors; 23 – L.G. nose strut; 24 – L.G. nose strut actuating cylinder; 25 – fuselage nose section.

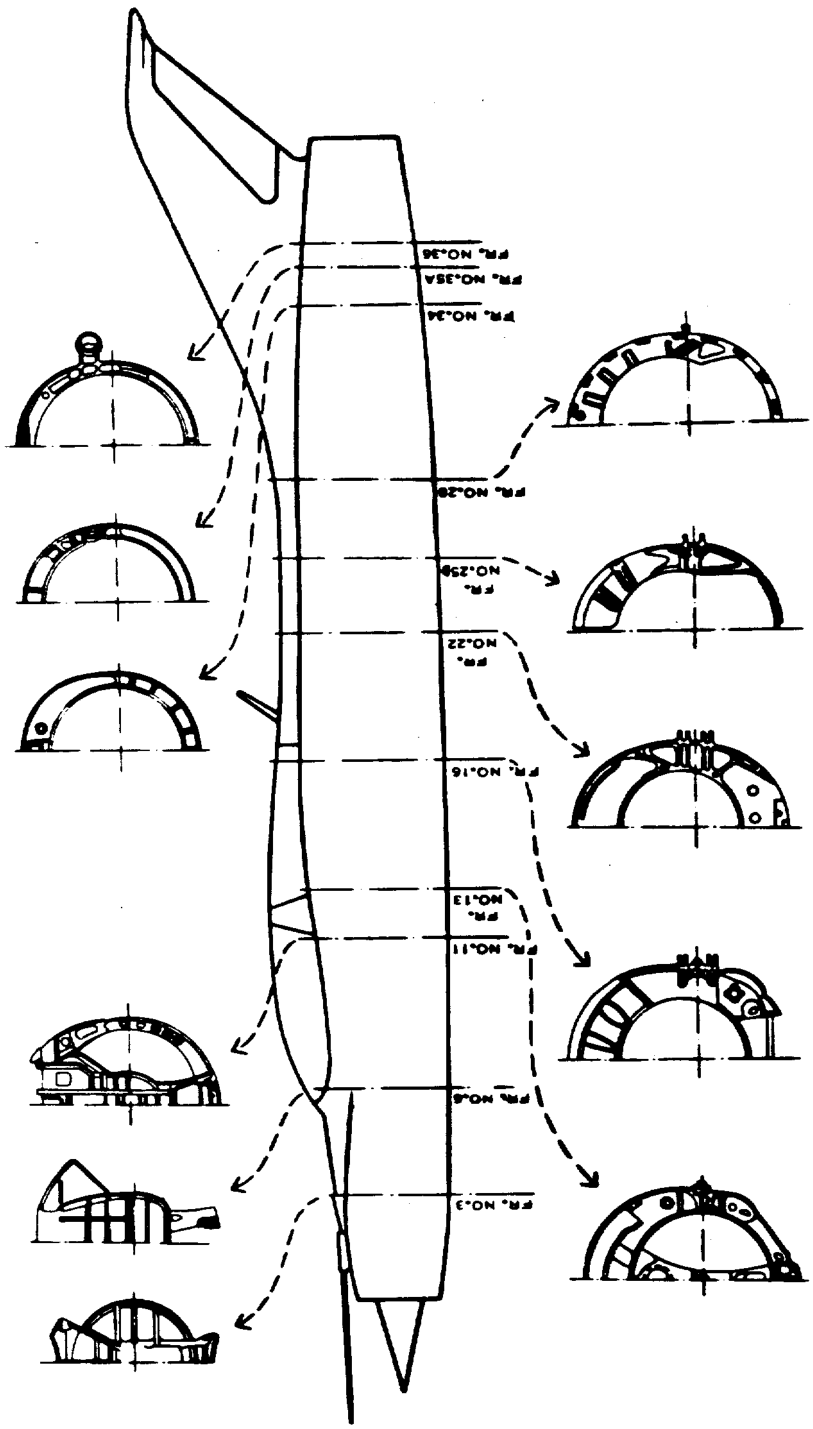

FIG.3. FUSELAGE LOAD-CARRYING FRAMES

In the lower section of the fuselage between frames Nos 16 and 20 (right, lef there is a well to accommodate the landing gear main strut wheels during retractic At top, between frame No.17 and the fin beam is arranged a superstructure mountin the rudder and stabilizer rods, radio electric wiring.booster БУ-51МС, pumping unit [illegible] and other aircraft control units. Part of the superstructure between frame No.16 and frame No.30 is removable and is fastened to the diaphragms and longitudinal shapes of the fuselage by means of screws and anchor nuts.

The fuselage bears a structural joint on frame No.28, which divides the fuselage into the nose and tail sections. The stabilizer fastening beam is installed o the fuselage tail section between frames Nos 35 and 36. The drag chute well is arranged below at the left-hand side between frames Nos 30 and 32. Below, between frame No.2[illegible] and the end of the fuselage is installed a ventral fin. The rear fuselage terminates in a movable tail cone.

The fuselage of this construction employs aluminum alloys Д16, B95, BM65-1, t: most stressed members being made of steels 30ХГСА, 30ХГСНА.

The aircraft is fitted with a triangle wing with the sweepback angle along the leading edge equal to 57°. The wing is made of airfoil sections with relative thickness at the root of 4.2% and at the tip, 5%.

Pilled to the wing are ailerons with axial aerodynamic balance and floating flaps.

Each wing outer panel has a well to accommodate a landing gear main strut. The outer panels are fastened to the fuselage at joints on frames Nos 13, 16, 22, 25 and 28. The wing has two hermetically sealed fuel compartments formed by the win structural elements.

The vertical tail unit consists of a fin and a rudder fastened to the fin members at three points. The fin is rigidly connected on the rear fuselage to frames Nos 34 and 36 by means of attachment units and is riveted to steel angles. The rudder has axial aerodynamic balance.

The horizontal tail unit comprises a controlled stabilizer, without an elevator. The stabilizer consists of two symmetrical halves (right and left) connected with the stabilizer attachment beams.

I. FUSELAGE NOSE SECTION

1. Construction and Arrangement

The fuselage nose section (Fig.4) is the most complex of the aircraft construction.

The transverse load-carrying assembly of the nose fuselage section includes [illegible] frames, frames Nos 1, 3, 6, 11, 13, 16, 20, 22, 25 and 28 being load-carrying members.

The longitudinal assembly is composed of longerons and beams with a few number of stringers which is compensated for by outer skins of considerable thickness.

Located in the front section of the fuselage is an air intake of variable inlet section area adjusted by a movable cone with a follow-up system. Arranged between frame No.3 and frame No.6 are two compartments: the upper and the lower. The upper compartment houses radio and electric equipment. The lower compartment is separated from the upper compartment by a horizontal partition and has a special well to accommodate the landing gear nose strut.

The cockpit housing the instruments and aircraft controls is located between frames Nos 6 and 11. Below the cockpit is arranged the storage battery compartment.

TABLE TO SKINS LAYOUT DIAGRAM

No. in diagram	Material and thickness of skin	Note
1	Д16АМ-δ3,8	The layout diagram shows only basic skins of the largest dimensions.
2	Д16АМ-δ1	
3;4	Д16АМ-δ1,5	
5;6	Д16АМ-δ1,2	
7;8	Д16АМ-δ2	Hatch door facings are not shown.
9	Д16АМ-δ1,2	
10;11	Д16АМ-δ1,2	
12;13	Д16АМ-δ2	Skins 15, 17, 19 and 21 which are symmetrical to skins 14, 16, 18 and are not shown in Fig.4.
14;15	Д16АМ-δ1,5	
16;17	Д16АМ-δ2,5	
18;19	Д16АМ-δ2,5	
20;21	Д16АМ-δ1,2	
22	Д16АМ-δ3	
23	Д16АМ-δ1,5	
24;25;	Д16АМ-δ2,5	
26;27;	Д16АМ-δ1,5	
28;29		

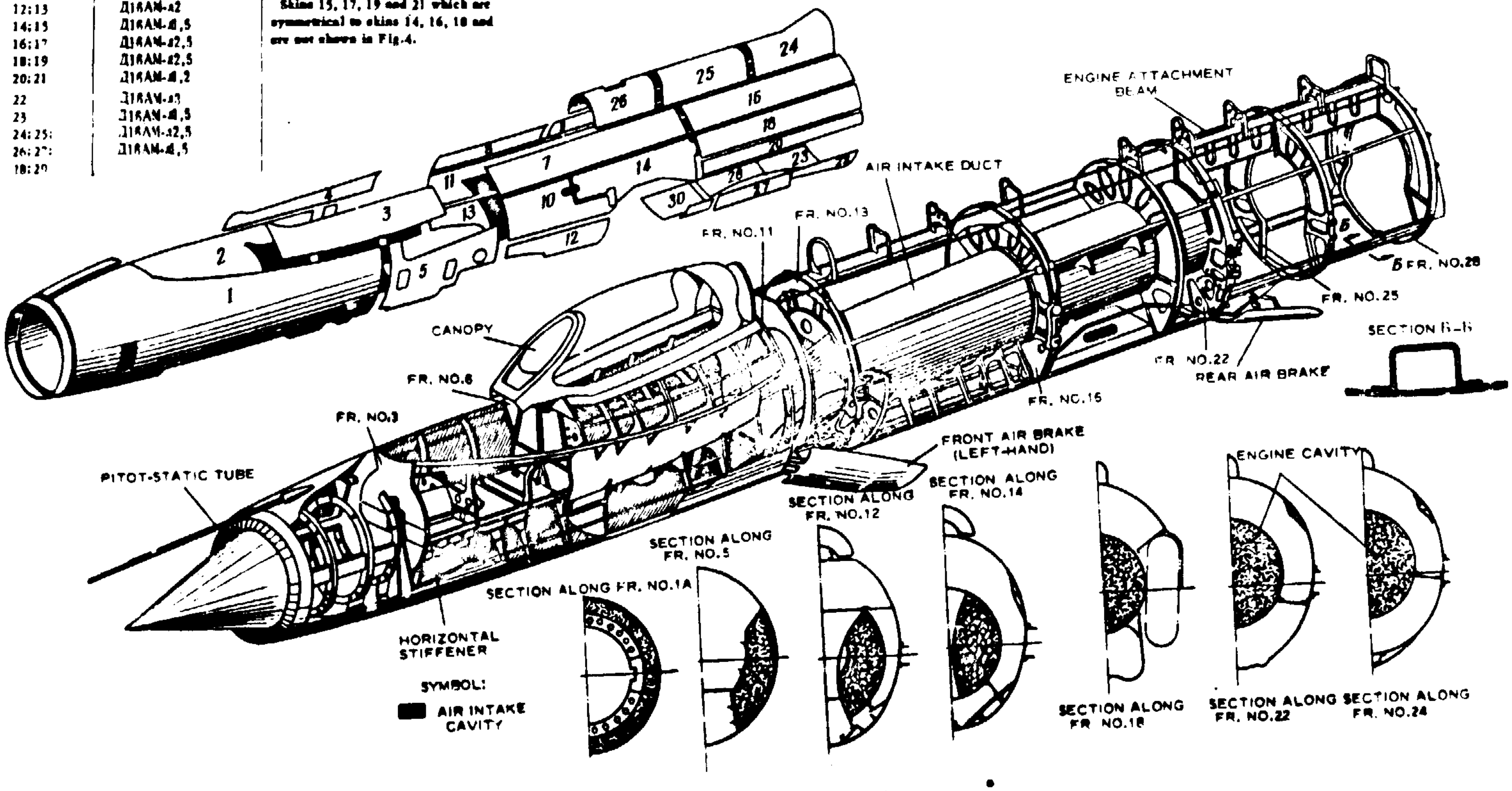

FIG.4. FUSELAGE NOSE SECTION STRUCTURE AND ARRANGEMENT (See the Skins Layout Table)

Behind the cockpit between frames Nos 11 and 25 there are containers for six bag-type fuel tanks:

(a) tank No.1 is located between frames Nos 11 and 13;

(b) tank No.2 is located between frames Nos 13 and 16;

(c) tank No.3, consisting of two parts, is located between frames Nos 16 and 20;

(d) tank No.4 is located between frames Nos 20 and 22;

(e) tank No.5 is located between frames Nos 22 and 25;

(f) tank No.6, consisting of two parts, is located between frames Nos 25 and 28.

The seventh, additional, fuel tank (metal one) is mounted on top the fuselage.

Arranged between frames Nos 16 and 20, on the left and right, are the wells for the wheels of the landing gear main struts (the main struts retract into the wings and the wheels are drawn into the fuselage).

The wells for the front air brakes are arranged on the left and right of the lower fuselage section between frames Nos 11 and 13. Below, between frames Nos 22 and 25 are located fastening members of the rear air brake and its hydraulic cylinder.

To accommodate the control rods and the electric and radio conductors, there is a movable superstructure cover located above the front fuselage between frames Nos 16 and 28. Installed in the nose fuselage section between frames Nos 22 and 28 is an engine attachment beam with a socket for the engine king pin at frame No.25.

The air intake running from the nose cone to frame No.22 is divided in front of the cockpit into two parts and then, behind the cockpit, joins again to form a common cylindrical duct.

The engine is mounted in the cylindrical cavity between frames Nos 22 and 28.

The air cooler of the cockpit air supply system is installed in the duct before the engine inlet.

The fuselage nose section accommodates a number of hatches to give access to the aircraft equipment.

2. Movable Cone

Arrangement of Movable Cone (Fig.5)

The movable cone is designed to increase the engine thrust at supersonic speeds of aircraft flight. The cone axis is inclined downwards at 3° to the aircraft reference line.

The movable cone is located between the front edge of the fuselage nose section and frame No.3 at the air intake inlet and falls into two sections: stationary 15 and moving 16.

Moving section 16 whose frame is formed by ring 18, beam 11, rails 4 and 6, shifts along guiding rollers 5 of stationary section 15. Ring 18 and inner rail 4 bear the radar station fastening units and together with beam 11 form the radar station attachment frame. Ring 18 is secured to the cone moving section by means of bolts 21; attached to ring 18 by nineteen bolts 20 is a radio-transparent cone (Place III). Moving section 16 is shifted under the action of the movable rod of hydraulic cylinder 12 connected with beam 11.

Stationary section 15 whose frame is formed by cast rings with rollers 8, diaphragms and stringers, is rigidly connected with the structural members of the fuselage nose section by means of upper 13 and lower booms (See the diagrams of the retracted and extended cone).

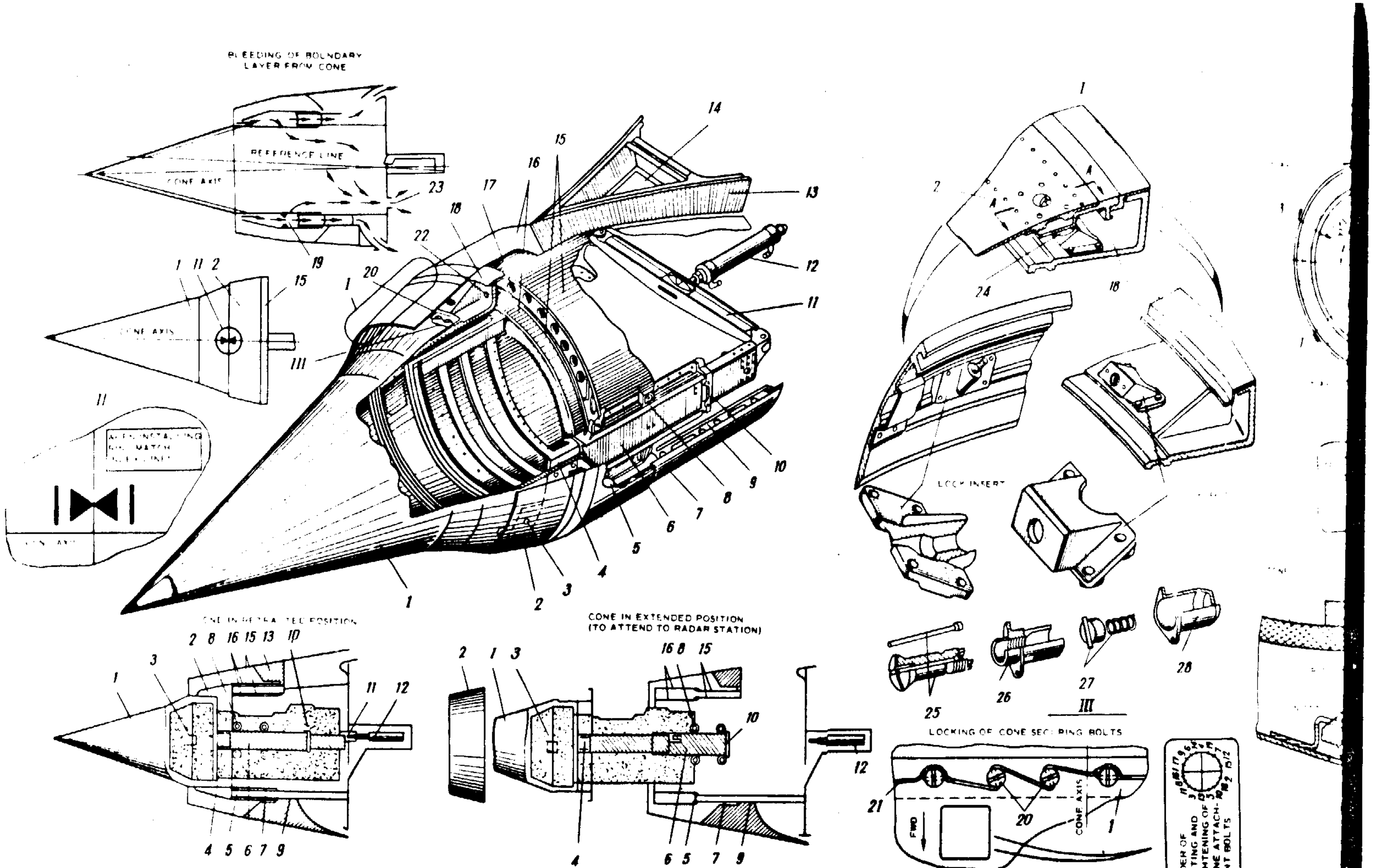

FIG.5. MOVABLE CONE

1 – radio-transparent cone; 2 – front ring; 3 – access hole to antenna scale; 4 – inner rail; 5 – frame No.1; 6 – outer rail; 7 – frame No.1A; 8 – rollers; 9 – frame No.2; 10 – outer rail support; 11 – beam; 12 – hydraulic cylinder; 13 – upper spoke of air duct; 14 – access hole to radar station; 15 – cone straight stationary portion; 16 – cone straight moving portion; 17 – gauzed holes for air circulation; 18 – ring; 19 – ring holes for air circulation; 20 – bolt; 21 – locking wire; 22 – bolt; 23 – valve to release air from compartment; 24 – lock of easily-removable ring; 25 – lock bolt with shaft; 26 – nut with flange; 27 – lock with spring; 28 – cap.

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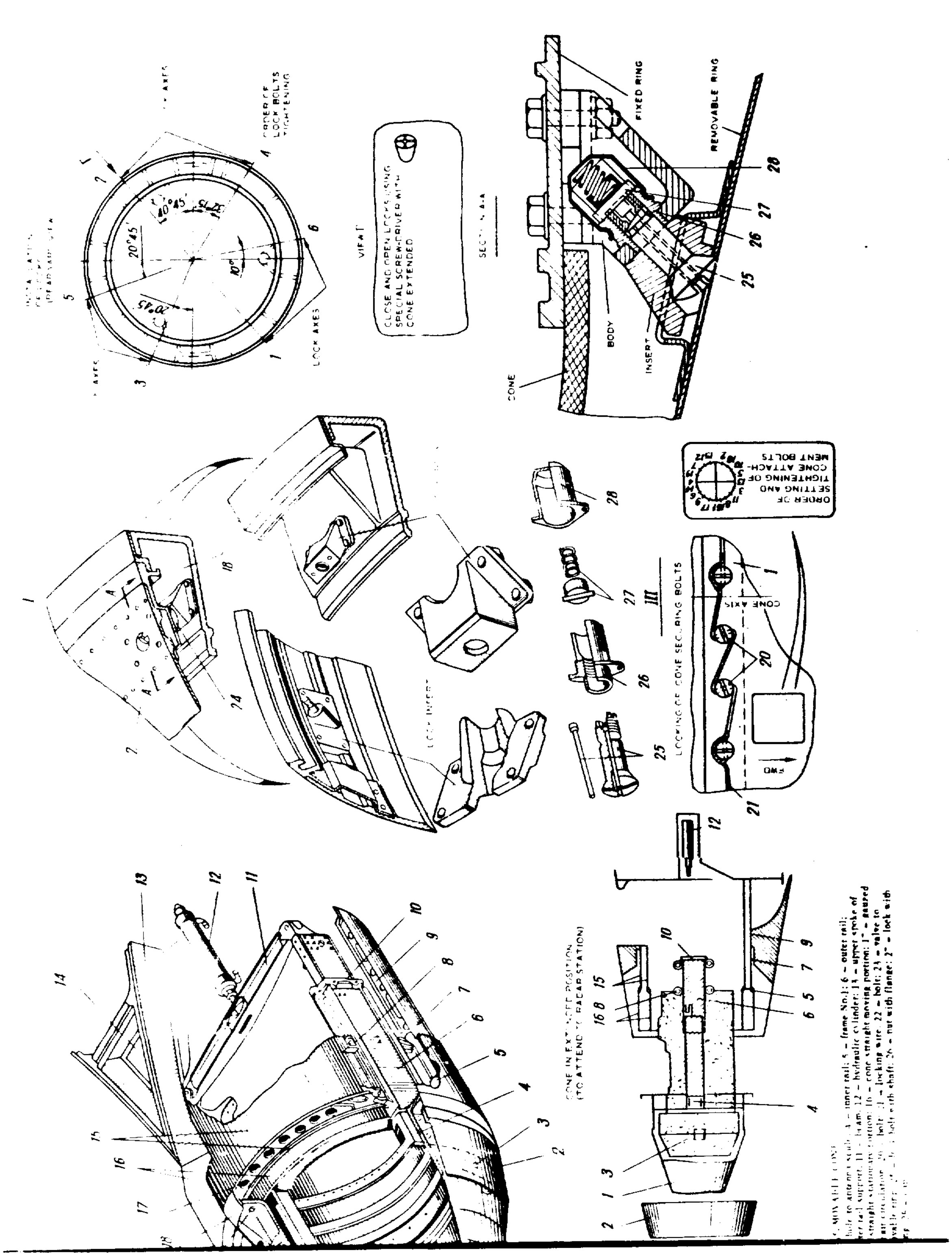

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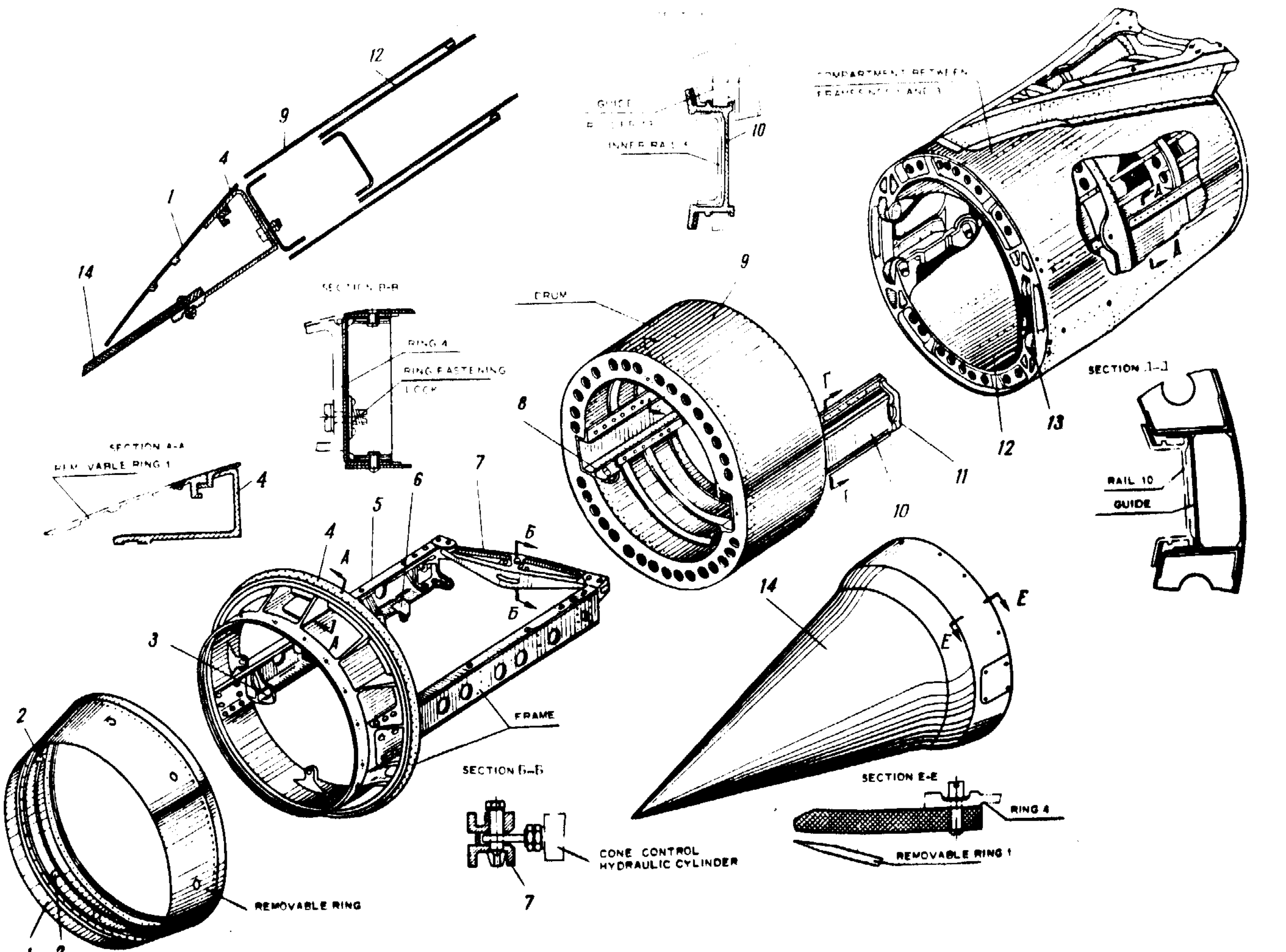

FIG.6. CONE ATTACHMENT UNITS

1 – removable ring; 2 – lock; 3 – radar station attachment bracket; 4 – ring; 5 – inner rail; 6 – service stop; 7 – frame beam; 8 – stop screw; 9 – drum with outer rail; 10 – outer rail; 11 – stop; 12 – stationary portion; 13 – roller; 14 – cone.

mediate skins; laid between the skins is curtain cloth. The cone is 14 mm thick, a: its top terminates in a stainless steel tip. Cone 14 is fastened to ring 4 by mean: of nineteen bolts (section E-E).

The stationary cone section is a compartment occupying the space between frames Nos 1 and 3 whose frame is formed, at frames Nos 1 and 1A, by cast electron rings coupled together by four electron diaphragms, a duralumin diaphragm at frame No.2, and a number of stringers and transverse diaphragms.

Mounted on the cast rings are eight steel rollers 13 to forward the direction of rails 10.

The frame of the stationary section is covered with duralumin sheets. In the lower pressurized part of frame No.3 there is a hatch cover giving access to the fuse box in the upper section of the compartment; located below the alcohol tank hatch is a hatch cover giving access to the electric cords of the special equipment and the hydraulic cylinder fastening bolt.

The hydraulic cylinder is secured to the unit on frame No.4 and is enclosed i: a hermetically sealed housing coupling the cylinder cavity with the compartment bet ween frames Nos 1 and 3.

Prior to removing the ring and disconnecting the hydraulic cylinder, the cone must be extended in the middle position by the hydraulic system or the hydraulic power cart.

Boundary Layer Bleeding and Blowing of Radar Station

To increase the effectiveness of the inlet section of the air intake the aircraft is fitted with a system for bleeding the boundary layer from the cone (Fig.5

The air is sucked in through the slit formed by easily removable ring 2 and radio-transparent cone 1; then the air is forwarded through the holes in cast ring 18, diaphragm and between the skins of the cone moving section into the radar station compartment for blowing purposes. The air is released through valve : in the lower part of frame No.3 into the well for the landing gear front strut and further into the atmosphere (See the boundary layer bleeding diagram). At high spee the aerodynamic heating leads to a considerable increase of temperature of the sucked-in air; therefore, during flights at M = 1.35 the valve is shut and blowing is stopped. For thermal protection of the radar units the inner skin of the radar compartment has thermal insulation of material АСИМ.

3. Compartments, Units and Assemblies of Fuselage Nose Section

Equipment Compartment

The equipment compartment is located in the upper part between frames Nos 3 and 6. The lower part of the space between the frames forms a well for the landing gear front strut; it is separated from the equipment compartment by a horizontal bulkhead having a stamped recess for the front strut wheel and a removable housing : the cone actuating hydraulic cylinder of the УВД-2М system.

The framework of this compartment is formed by frame No.3 through to frame No.: and by a number of stringers and shapes. The compartment accommodates radio and electrical equipment. Access to this equipment is provided through a special hatch whose cover is fastened to the compartment shapes by means of locks.

Frames (Fig.3)

Frame No.3 is fabricated as a web made of material Д16 having a rim and a set of shapes riveted to it. Part of the frame limited by the rim is made airtight by covering the rivet seams with sealing varnish У-30М. The upper and lower parts of the frame have extending non-pressurized superstructures. The central part of the frame mounts a removable hatch cover and a framing with anchor nuts to fasten the housing of the cone actuating hydraulic cylinder.

Frame No.6 is load-carrying; it is a web reinforced at its contour by angles and vertical pressed angles. Secured to the frame are the nose strut attachment fitting and the front armour plate. In the lower part of the frame a cut-out is made for the landing gear nose strut and a stop is fitted to retain the strut in the extended position.

Frame No.11 is a load-carrying web with shapes. Secured to it are the rollers of the ejection seat and the bell-cranks of the aircraft control system. The upper part of the frame constitutes a single whole with the canopy-mounting panel.

Frame No.13 is a load-carrying web with a hole for the air intake. The frame web is reinforced with shapes. On the left and right sides of the frame there are attachment fittings fastening the wing to the fuselage.

The lower part of the frame is a load-carrying assembly: it carries the bell-cranks of the aileron control system.

Frame No.16 is load-carrying; it is a ring formed by a web and angles. Mounted in the middle of the frame are strips with the remaining attachment fittings for securing the wing to the fuselage.

Frame No.20 is a load-carrying web made in the form of ring and reinforced with shapes. Jointed to the left and right sides of the frame by means of angles are wells for the landing gear main wheels. The lower part of the frame bears a bracket of the rear attachment fitting of the drop tank pylon.

Frame No.22 is the main load-carrying frame for wing attachment. At this frame the air intake duct terminates and the engine compartment begins. The frame consists of four parts joined by bolts. The upper and lower parts of the frame are of I-section.

Fastened to the central upper part of the frame is the engine attachment beam, while to the lower part of the frame are joined the attachment fittings of the engine control system bell-cranks. The left and right parts of the frame are cross-pieces of I-section. Each of them is fitted with four forked units for attachment to the upper and lower parts of the frame and four horizontal lugs of the wing attachment fittings.

Frame No.25 is a load-carrying horseshoe frame with a lower arch of I-section. The main part of the frame consists of two halves joined on the engine mounting beam. On the frame web there is a number of reinforcing struts and in the middle, on its both sides, there are reinforcing straps and shapes to which steel attachment fittings of the wing are secured. The lower part of the frame consists of two stamped diaphragms between which a beam is attached. The beam carries an attachment fitting of the rear air brake cylinder and the engine attachment unit.

Frame No.28 is the last member of the fuselage nose section which serves as a joint frame between the fuselage nose and tail sections. The frame is a rim with a reinforcing angle to which a sheet web is riveted. Lock washers for joint bolts are riveted to the outer rim. Secured to the middle part of the frame are three additional engine attachment units and the wing rear attachment fittings in the form of telescopic retractable supports with cups.

Landing Gear Nose Strut Well

The landing gear nose strut well located in the lower space between frames Nos [illegible] and 6 is formed by the skins of the air intake walls and the horizontal bulkhead separating the well from the equipment compartment. The well framework is formed by the frame webs and stringer shapes.

A steel attachment unit of the landing gear strut (Fig.7) located at frames Nos 6-7A is the main load-carrying element of the well.

During the flight the landing gear nose strut is retracted and the well is closed with doors. The well doors and their closing mechanism are dealt with in Chapter "Take-Off and Landing Equipment".

Cockpit (compartment between frames Nos 6 and 11)

Frames, stringers, upper and lower longerons and the canopy-mounting panel with a channel for a sealing hose form the framework of this compartment.

The upper part of the compartment forms the cockpit. The lower part of the compartment accommodates the storage battery assembly. The cockpit is separated from the storage battery section by a floor. The control rods running on the cockpit floor are closed with an additional removable floor.

The cockpit is made airtight at frames Nos 6 and 11, all the bolt and rivet joints being coated with a layer of sealing varnish. Rivet seams of the cockpit sheets are also made airtight, being covered with sealing varnish laid on glue. At jointing the cockpit and the canopy have a rubber sealing hose passed on the canopy-mounting panel.

Thermal-and-sound insulation of the cockpit is performed by thermal-and-sound lining applied to the cockpit sheets. For the cockpit thermal-and-sound insulation and pressurization diagram see Fig.8.

Landing Gear Main Strut Wheel Well

The landing gear main strut wheel well is located between frames Nos 16 and 20. The well is intended to accommodate the retracted landing gear main strut wheel. The well is formed by the webs of frames, skin of the suction channel and rigid webs fastened to the frame shapes. When in flight, the well is closed by a door. The door is fixed in the closed position by a lock. The lock is opened under the action of the main strut up-lock actuating the door lock mechanism through a cable (See Fig.9).

The well door lock consists of body 3 housing lever 1, hook 4 and spring 7. Lock body 3 is bolted to the web of frame No.16. The lug of lever 1 is connected with its one end to spring 8 mounted on the web of frame No.16 and with the other, to cable 10 passing through the bracket with roller 9 also installed on the web of frame No.16.

When the landing gear main strut retracts, the well door (actuated by the hydraulic cylinder) presses with its rod 5 the middle projection of hook 4. Hook 4 spinning on axle 6 presses with its upper projection the shorter arm of lever 1 making it turn about axle 2 till the upper projection of hook 4 engages the shorter arm projection of lever 1. As a result, the lock gets latched and the well door is closed.

When the landing gear main strut extends, the pull of cable 10 from the main strut up-lock is imparted to the longer arm of lever 1, to lift it up; the shorter

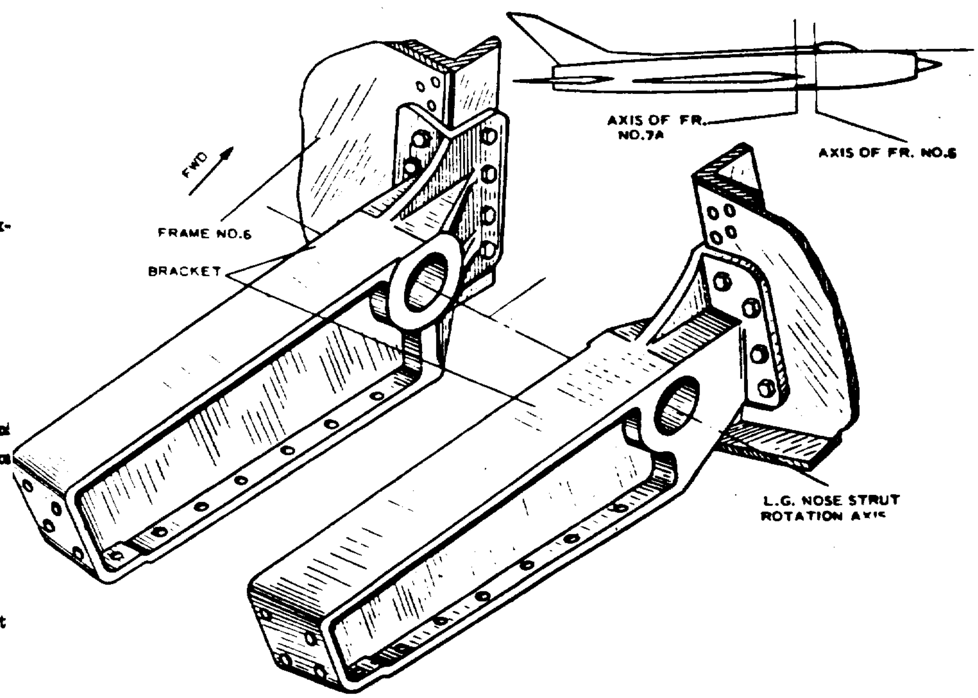

FIG.7. L.G. NOSE STRUT ATTACHMENT UNIT

Basic Specifications

Rack weight:

(a) with the P-3C missile suspended .... [illegible] at most

(b) with rocket missiles suspended .... 23.5 kg at most

(c) with bombs suspended .... 27.5 kg at most

Overall dimensions:

(a) length .... [illegible] mm

(b) width .... 62 mm

Missile suspension signalling.... light, electric

Type of rack-to-wing attachment.. pivot

Suspension adjustment angles:

(a) along the vertical line $\pm 30'$

(b) along the horizontal line .... $\pm 25'$

Construction

The rack, type БД3-60-21УМ (Fig.6), is cast beam 14 rectangular section with lateral and longitudinal reinforcing ribs inside. The front and rear ends of the beam are closed with fairings 3 and 21.

The upper contour of the rack is shaped after that of the wing over its lower surface and has rubber gasket 4 to ensure a tight fit with the wing.

Beam (frame) 14 is a basic structural element of the rack. In the beam lugs on the top, taper bolts 9 and 16 of the beam front and rear attachment units to the wing units are secured in position by means of special bolts 10 and 20.

When attaching the rack, insert these taper bolts into wing special units 8 and 17. The taper bolts have expanding bush-rings 5 and 15 with taper holes. When tightening up nuts 6 and 18 screwed on the cylindrical threaded part of the taper bolts, the beam is pressed to the wing and the expanding bush-rings ensure a tight connection without play.

Rear taper bolt 16 and the rack beam bush have oval holes for bolt 20 and for cylindrical part of rear taper bolt 16, respectively, which makes it possible to eliminate error of

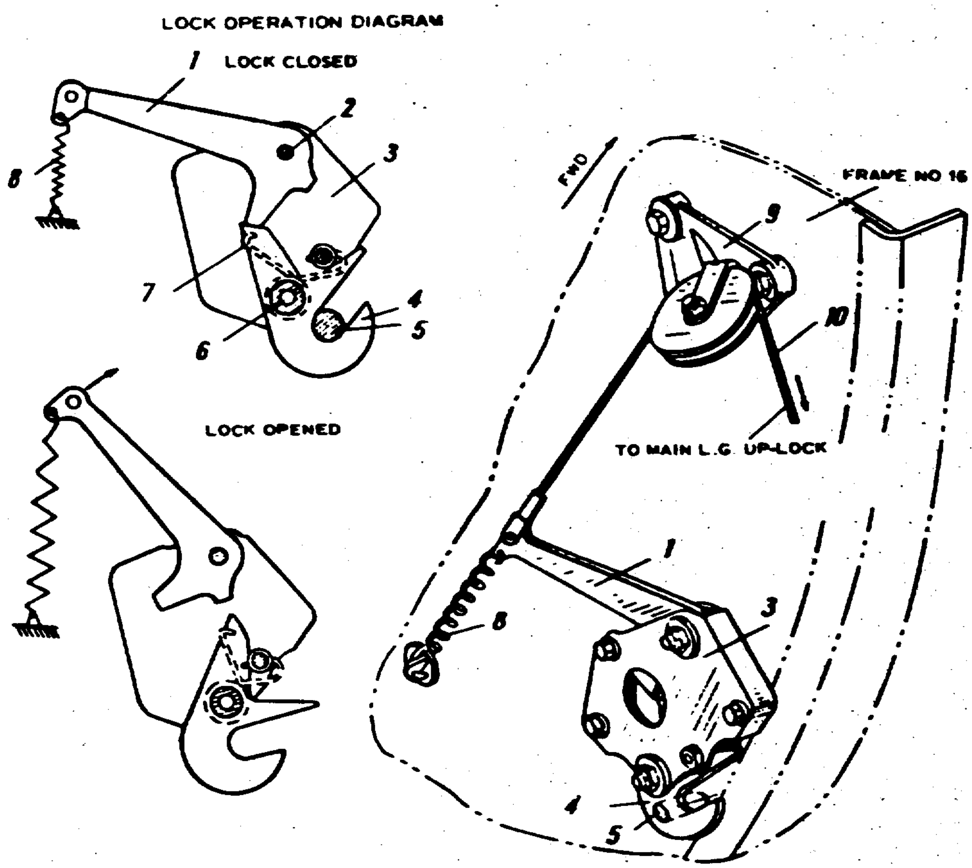

FIG.9. L.G. MAIN WHEEL DOOR LOCK

1 – lever; 2 – lever axle; 3 – lock body; 4 – lock hook; 5 – main wheel door rod; 6 – hook axle; 7 – spring; 8 – spring; 9 – bracket with roller; 10 – cable.

arm of lever 1 slides with its projection along the projection surface of hook 4 and unmeshes it; acted upon by spring 7 hook 4 moves to the initial position; as a result, the lock gets unlatched. Actuated by the hydraulic cylinder, the well door moves into the extreme lower position.

Front Air Brake Well

The front air brake well is formed by two load-carrying beams bolted to the webs of frames Nos 11 and 13.

At the air brake attachment units the well is reinforced by three additional diaphragms (Fig.10).

At frame No.13 between the well beams is mounted a universal rod fastening the air brake actuating hydraulic cylinder.

Universal rod 12 securing the hydraulic cylinder is mounted between beams 2 and 6 is fastened to them by means of bolt 11 passing through bearing 10 (section B-B). Universal rod 12 is joined to hydraulic cylinder unit 14 with the help of bolt 13 (section Б-Б). The attachment of air brake suspension 3 is performed by bolt 1 (section A-A).

Arrangement of Rear Air Brake Attachment Units

The rear air brake is installed between frames Nos 22 and 25 (Fig.11). The air brake units are fastened to steel bracket 1 riveted to the web of frame No.22 and load-carrying beam 5 of the fuselage framework. Rear air brake units 4 are secured to bracket 1 on frame No.22 by a special stepped bolt.

The rear air brake actuating hydraulic cylinder is fastened by means of universal rod 7 installed on the hydraulic cylinder which in its turn is secured by bolt 8 to bracket 9 and beam 5 of the fuselage framework (section Б-Б).

To preclude the rear air brake sagging the air brake is provided with a fixing lock. The lock consists of spring 10, and latch 11 installed at frame No.25. The air brake is opened and closed by the action of the hydraulic cylinder.

Construction of Fuselage Air Brakes

Arranged in the lower part of the fuselage are three air brakes controlled hydraulically: two front and one rear.

The front air brakes have the total area of 0.884 m^2, their deflection angle being 25°.

The area of the rear brake is 0.47 m^2 and its angle of deflection is 40°.

The front air brakes (left and right) are located between frames Nos 11 and 15.

The air brake attachment units are arranged on frame No.11. Each air brake is hinged on two brackets.

Each air brake is of riveted construction and consists of outer and inner facings, diaphragms, beams and shapes.

The rear air brake is arranged between frames Nos 22 and 25. The air brake actuating hydraulic cylinder is fastened to frame No.25 by means of a universal rod.

The front part of the air brake have two attachment units.

Engine Attachment Beam

The engine attachment beam (Fig.13) is built between frames Nos 22 and 28 in the upper section. The beam is web 2 divided into lower part 7 and a bent upper

The tail fairing contains a skin and a special bushing riveted to the skin. The special bushing has a slot in its lower portion for the stabilizer of a bomb (ФАБ-500).

Secured in the lower part to the skin is the diaphragm, and on the top, a rubber profile.

Riveted in the centre of the fairing is a bracket designed for passing the pulse feeding mechanism balls with arming rod. A bracket mounted in the upper portion of the fairing by means of anchor nuts is designed for securing two pulse feeding mechanisms.

On the starboard and port side of the fairing there are hatches for access to pulse feeding mechanisms. The hatches are closed by covers and locked.

Two anchor nuts are riveted in the lower part for securing the adapter beam.

To eliminate the slip gap between the rack and the launcher, type АПУ-3С, or the rocket pod, type УБ-16-57У, secured to the lower surface of the rack is a light adapter beam (Fig.7). The adapter beam consists of three parts (front, middle and rear) in order to secure the stops.

The parts of the adapter beam are identical in construction.

Every part consists of fixed cover 8 and movable bottom 4.

The fixed cover is made as a П-shaped profile. Riveted to its upper surface are two bushings 7 with holes for pin 6 and plate springs 9.

The lower part - movable bottom 4 is also of a П-shaped section. It enters the cover making a telescopic joint. Riveted to the bottom lower surface are two bushings 5 having a longitudinal groove for pin 6.

Bottom bushings 5 are inserted into cover bushing 7 and coupled by pins 6.

Free ends of springs 9 thrust into the bottom lower surface and thus press down the bottom and eliminate the gap between the rack and the launcher or rocket pod.

The upper surface of the cover and the lower surface of the bottom have a number of holes for launcher suspension units for access to pins 6 and for access to adapter beam securing bolts.

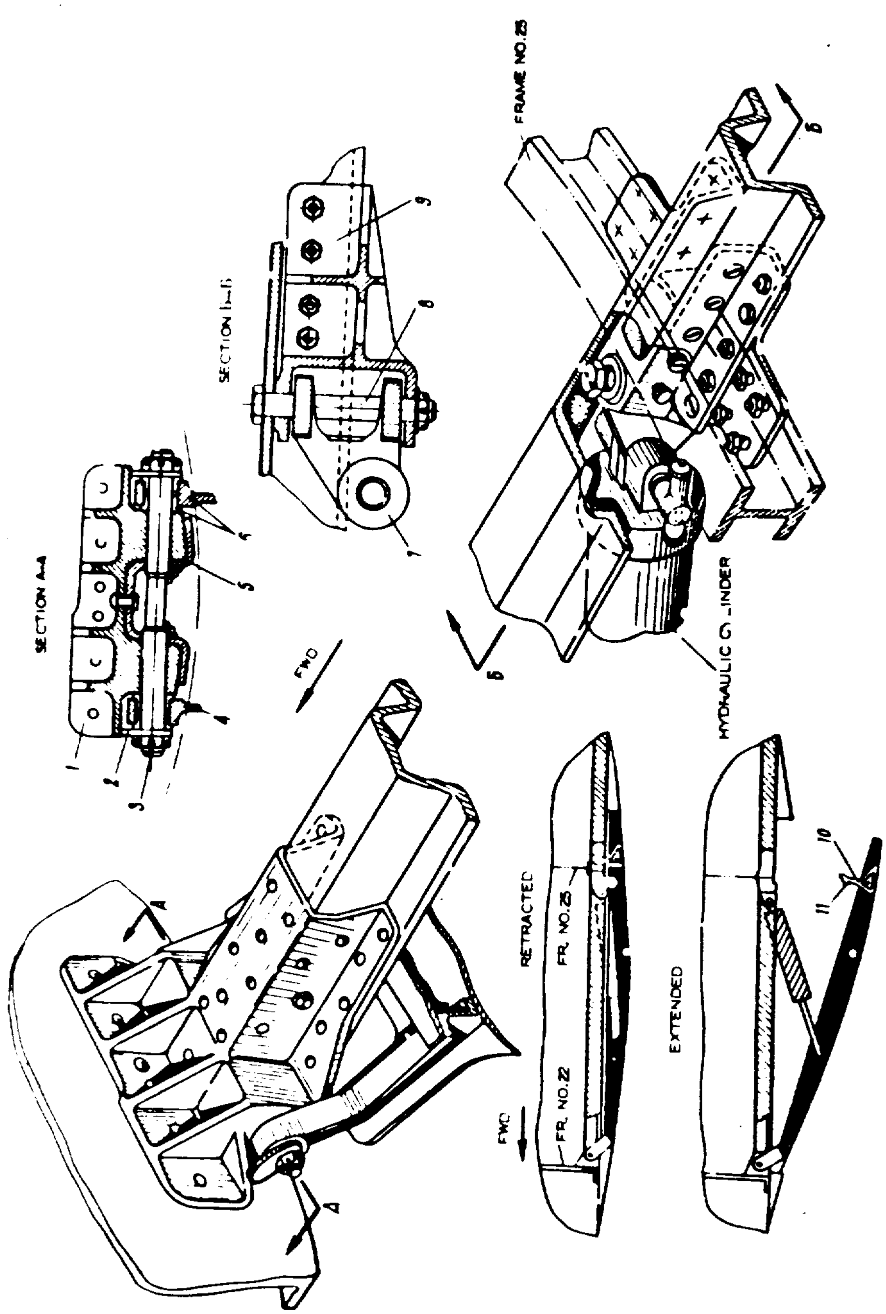

FIG.1:. REAR AIR BRAKE ATTACHMENT UNITS

1 – bracket; 2 – washer; 3 – bolt; 4 – air brake unit; 5 – frame beam; 6 – bushing; 7 – universal rod; 8 – bolt; 9 – bracket; 10 – lock spring; 11 – lock latch.

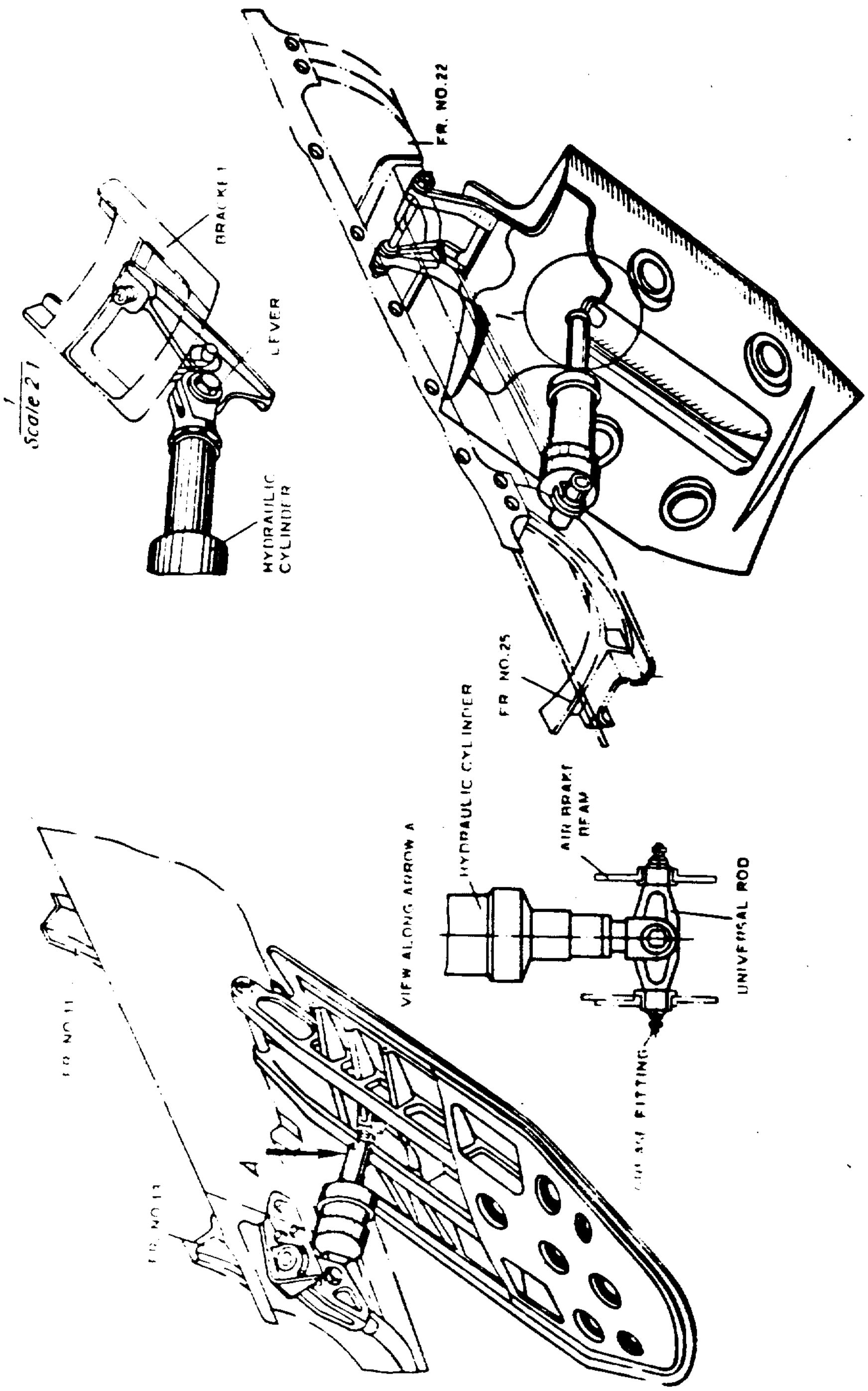

FIG.12. AIR BRAKES

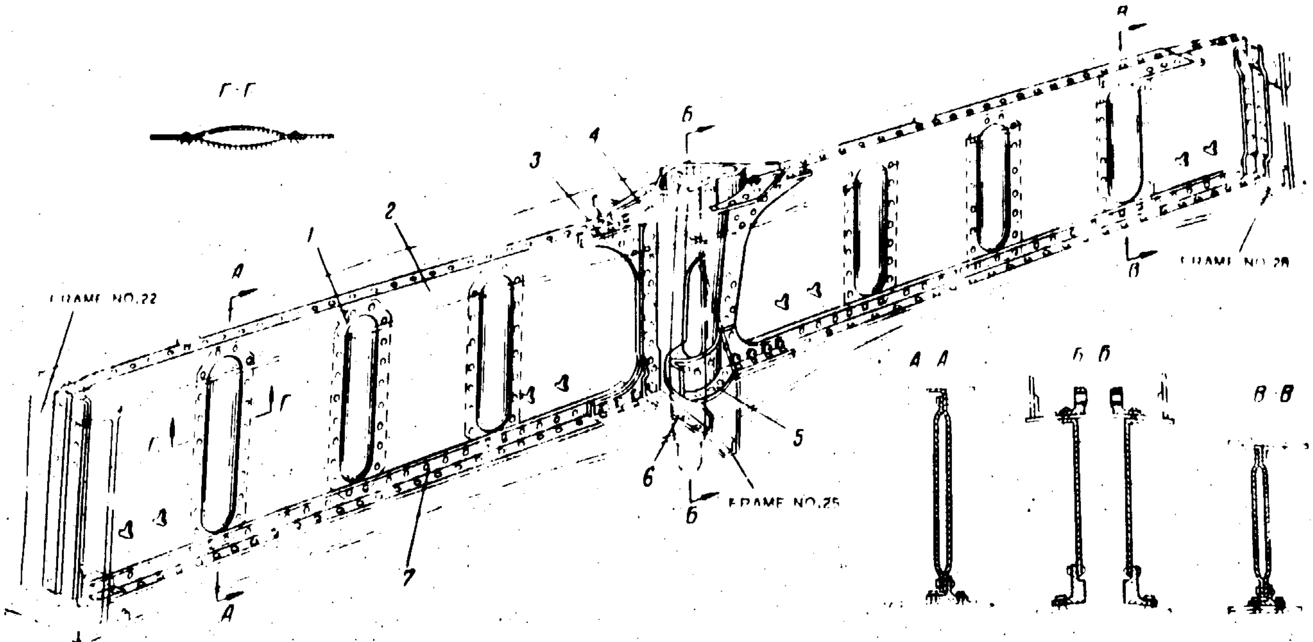

FIG. 13. ENGINE ATTACHMENT BEAM

1 – support; 2 – wall; 3 – sup[illegible]; 4 – upper attachment unit; 5 – lower attachment unit; 6 – knee plate; 7 – shape

part. In the beam on frame No.25 there is a socket for the king bolt of the main engine attachment fitting. The upper part of the socket carries unit 4 for the bolt of the king bolt and its lower part mounts steel supporting unit 5.

Fuselage Nose-to-Tail Section Jointing Unit

(Fig.14)

The fuselage nose and tail sections are jointed at frame No.28 of the nose section and at frame No.28A of the tail section. The joint is of a flange type and has three guide pins 13 and eighteen joint bolts 14. The bolts are riveted to the frame rim and have star-shaped heads for locking washers.

Fuselage-to-Wing Jointing Unit

(Fig.14)

The fuselage-to-wing jointing units are located on frames Nos 13, 16, 22, 25 and 28.

The joint at frame No.13 is of a fork type with one vertical bolt.

The joint at frame No.16 is fitted with upper and lower forks located in the horizontal plane and with a middle lug in the vertical plane. Each fork is fastened by a vertical stepped bolt while the middle lug is fastened by a horizontal bolt cantilevered in the wing spar lug.

The joint at frame No.22 is a fork type with two vertical jointing bolts. The joint at frame No.25 is of a fork type, the jointing being performed by a bolt with a nut.

Jointing at frame No.28 is effected by a bolt screwed and locked on the side of the first rib of the wing in the telescopic forked unit.

For arrangement of hatches in the fuselage nose section see Fig.15.

II. FUSELAGE TAIL SECTION

Construction and Arrangement

(Fig.16)

The fuselage tail section framework is made of two load-carrying assemblies: transverse frames and longitudinal stringers.

The transverse load-carrying assembly consists of thirteen frames of which frames Nos 28A, 34, 35A and 36 are the most stressed. Frame No.28A is jointed with frame No.28 of the fuselage nose section at eighteen jointing points and is made of a special pressed shape. Frames Nos 34, 35A, 36 are made of steel as webs, belts and stamped units.

The longitudinal load-carrying assembly is made of pressed shapes of angular section.

The skins are secured to the frames and stringers by riveting. Fig.16 presents the layout of the skins with thickness indicated (See Specification to Fig.16).

Between frames Nos 30 and 32 on the left side of the fuselage bottom there is a bay for the drag chute with a hermetically sealed screen of the drag chute container. Located between frames Nos 30 and 31 on the fuselage bottom on the right side is the antenna of the MPH-56П receiver. In the upper part of the fuselage between frames Nos 31 and 34 there is a compartment to accommodate hydraulic accumulator and hydroelectric valves.

For heat insulation of the hydraulic storage battery compartment and the drag chute container use is made of thermal insulation material АТИМС-5 ЕТУ No.С-1-57.

ors in the tail fairing) to reduce the current arising during accidental body faults (in which case the automatic circuit breaker of the aircraft bomb release control system may fail).

Rack Stops and Clamps

The rack is equipped with two pairs of stops and a pair of clamps (Figs 9 and 10) to suspend the launchers and rocket pods with different bases of stops, as well as to suspend bombs.

In the first pair the front stop has a 60-mm base, while the rear stop has a 52-mm base. This pair is used when the АПУ-3С launcher with the Р-3С missile is suspended from the rack.

In the second pair the front stop has a 120-mm base, while the rear stop has a 108-mm base. This pair is used when the rocket pod, type УБ-16-57У, with rocket missiles С-5М or С-5К is suspended.

The front and rear clamps are used for suspension of bombs; in this case the stops and adapter beam are removed.

Front stop 6 or 12 (Fig.9) is made as a holder with a round smooth pivot, housing the mating stop of the rocket pod or the launcher.

Fairings 7 are secured on stop 6 by screws 5. Mounted on the pivot end is a retaining device containing detent 9, detent casing 10, threaded plug 11 and spring 30.

The retaining device is secured on the pivot end by means of plug 11. With the detent being pressed down the stop pivot is inserted into the recess of adjusting bush 3 and is fixed in position on the latter by means of the detent which is forced out of the body by spring 30 (the stop being completely inserted) and falls behind the adjusting bush end-face. Adjusting bush 3 is screwed into attachment bush 2 which is press-fitted into rack body 1.

From the right-hand side of the starboard rack and from the left-hand side of the port rack there are: a groove in rack body 1 and attachment bush 2 for access to detent 9 of the pivot mounted in the rack.

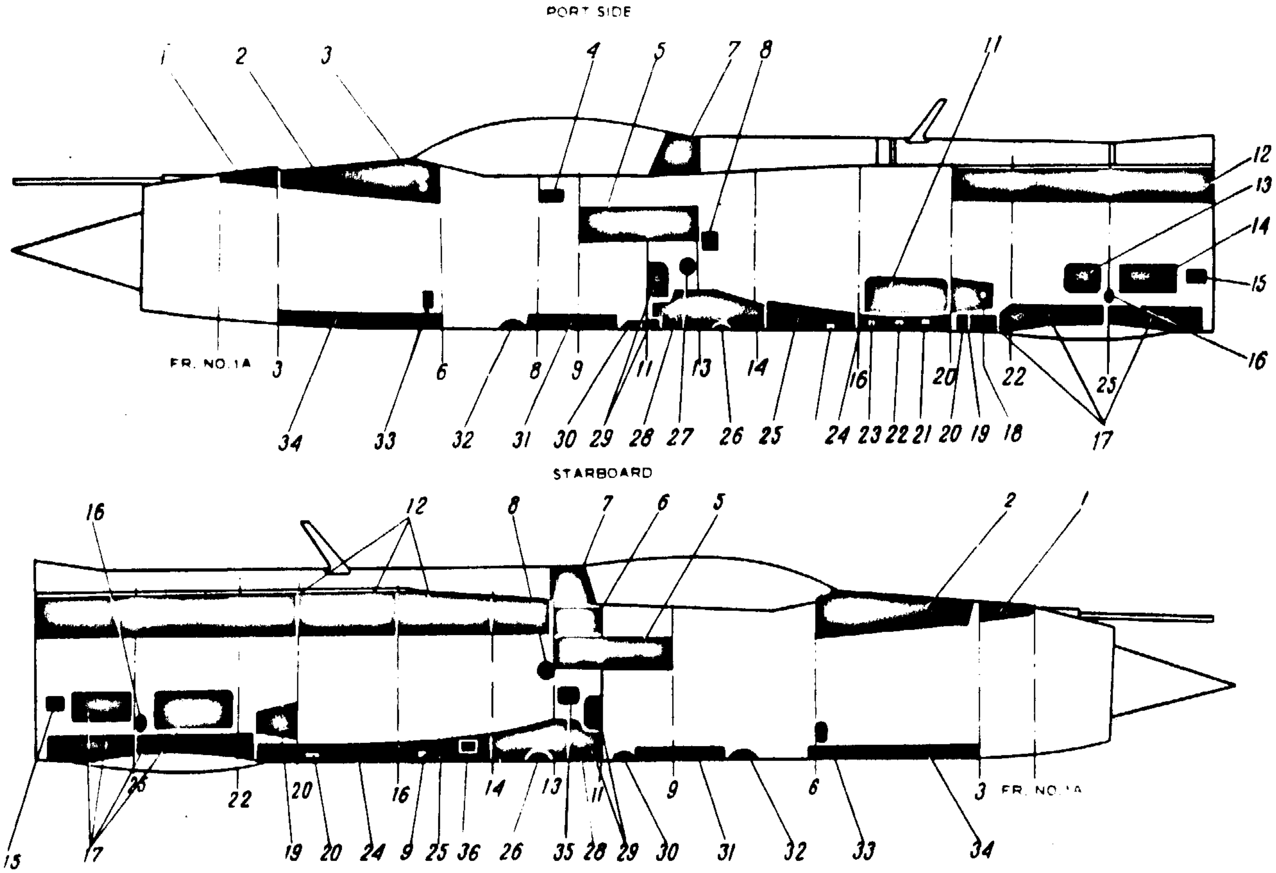

FIG.15. ARRANGEMENT OF SERVICE HATCHES IN FUSELAGE NOSE SECTION

1 – de-icing system alcohol tank, 2 – radio and special equipment units; 3 – inertia contactor, 4 – canopy emergency jettison handle ground lock, 5 – power distribution unit, 6 – electrical equipment units, 7 – superstructure; 8 – radio and electrical wires; aileron control rod; 9 – screw adjustment of box KAP-13-3; 10 – units APK-10 and PCHB-3, 11 – unit No.3, 12 – boxes Nos 2, 3, 4, 5 and 6; 13–14 – engine units; 15 – ground hydraulic pump connections, 16 – engine attachment; 17 – engine units; 18 – HHP pump sediment drain, 19 – hydraulic units; 20 – pylon electric connections; 21 – fire-fighting shut-off valve; 22 – fuel system pump sediment drain; 23 – sediment drain from the 2nd and 3rd fuel tanks; 24 – fuel system pump; 25 – electric equipment units; 26 – fuel drainage from the 1st group of tanks, 27 – airfield supply socket, 28 – air brake; 29 – air brake fastening bolts; 30 – airfield supply socket; 31 – storage battery; 32 – APK radio compass; 33 – L.G. nose strut axle; 34 – L.G. nose strut well, 35 – electrical equipment; 36 – unit checking connection; 37 – sediment drain from pump of tank No.2.

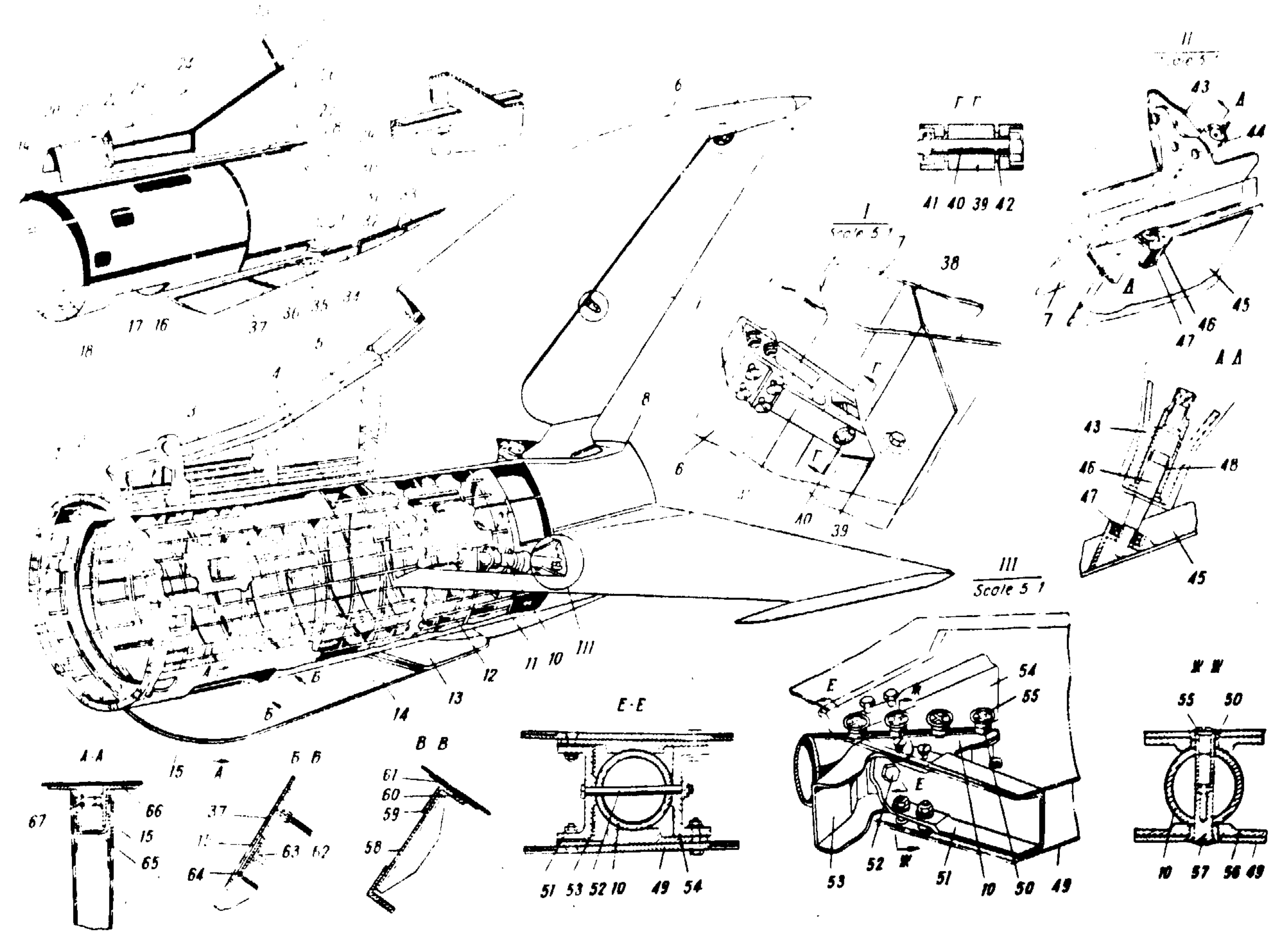

FIG.36. CONSTRUCTION AND ARRANGEMENT OF FUSELAGE TAIL SECTION

1 – frame No.[illegible]; 2 – frame No.20; 3 – superstructure groove; 4 – shares; 5 – fin beam; [illegible] – fin; 7 – rudder; 8 – tail cone; 9 – stabilizer; 10 – stabilizer beam; 11 – frame No.36; 12 – frame No.35A; 13 – frame No.34; 14 – ventral fin; 15 – ventral fin removable portion; [illegible] – skin; 38 – rudder unit; [illegible] – shackle; 40 – jointing bolt; 41 – fin unit; 42 – unit sleeve; 43 – fin unit; 44 – [illegible]; 45 – rudder bracket; 46 – axle; 47 – bearing; 48 – unit sleeve; 49 – stabilizer skin; 50 – sleeve; 51 – stabilizer frame beam; 52 – bolt; 53 – box; 54 – stabilizer frame beam; 55 – jointing bolt; 56 – plate; 57 – bolt; 58 – shape; 59 – web; 60 – ribbon; 61 – frame stiffener; 62 – ventral fin diaphragm; 63 – anchor nut; 64 – ventral fin diaphragm; 65 – ventral fin groove; 66 – shape fastening removable portion of ventral fin; 67 – anchor nut.

Inset A Secret

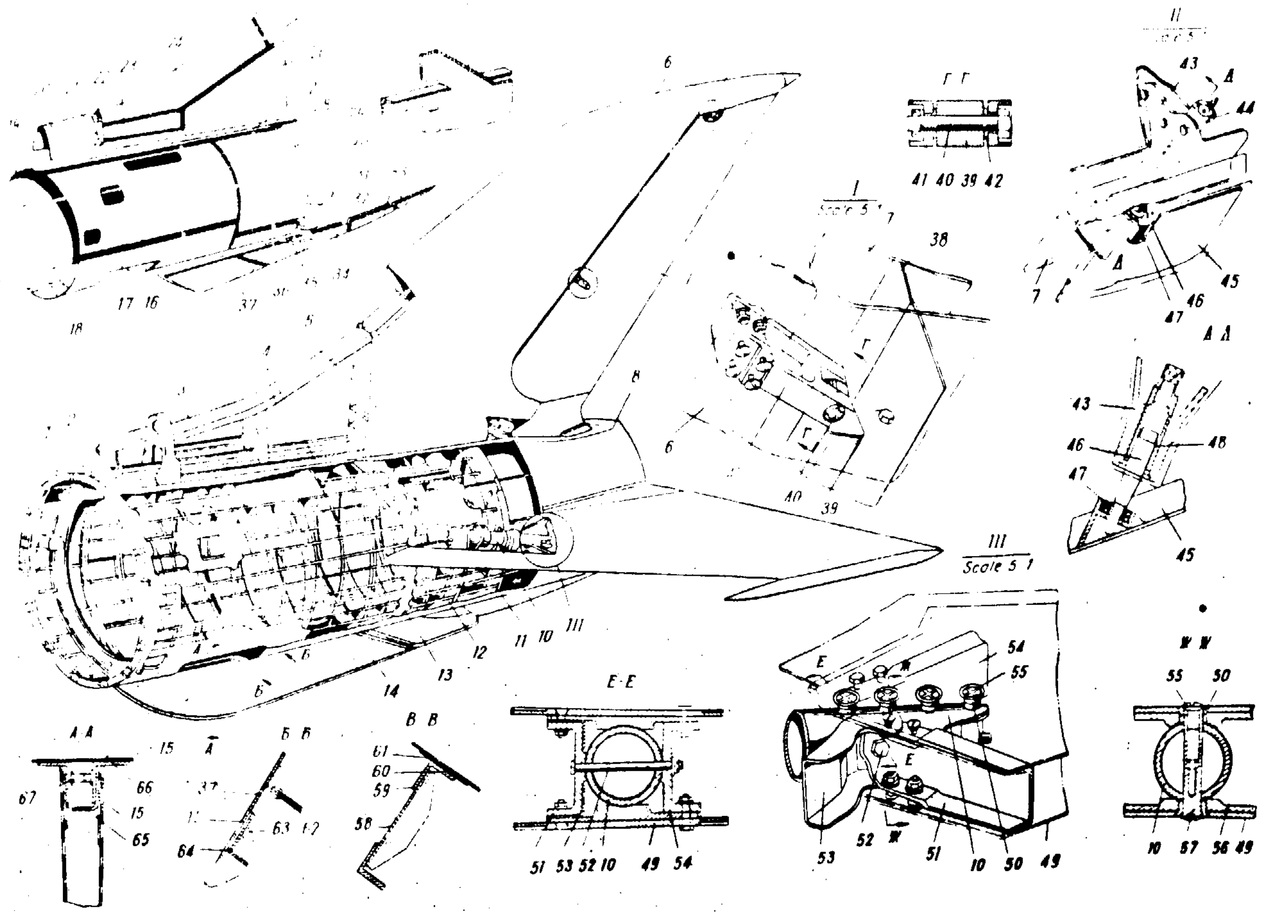

FIG.16. CONSTRUCTION AND ARRANGEMENT OF FUSELAGE TAIL SECTION

1 – frame No.[illegible]; 2 – frame No.20; 3 – superstructure groove; 4 – shapes; 5 – fin beam; [illegible] – fin; 7 – rudder; 8 – tail cone; [illegible] – stabilizer; 10 – stabilizer beam; 11 – frame No.36; 12 – frame No.[illegible]; 13 – frame No.[illegible]; [illegible] – ventral fin; 15 – ventral fin removable portion; [illegible] – [illegible]; 36 – rudder [illegible]; [illegible] – shackle; 40 – jointing bolt; 41 – fin unit; 42 – unit sleeve; 43 – fin unit [illegible]; 44 – [illegible]; 45 – rudder bracket; 46 – axle; 47 – bearing; 48 – unit sleeve; 49 – stabilizer skin; 50 – sleeve; 51 – stabilizer frame beam; 52 – bolt; 53 – box; 54 – stabilizer frame beam; 55 – jointing bolt; 56 – plate; 57 – bolt; 58 – shape; 59 – web; 60 – ribbon; 61 – frame stiffener; 62 – ventral fin diaphragm; 63 – anchor nut; 64 – ventral fin diaphragm; 65 – ventral fin groove; 66 – shape fastening removable portion of ventral fin; 67 – anchor nut.

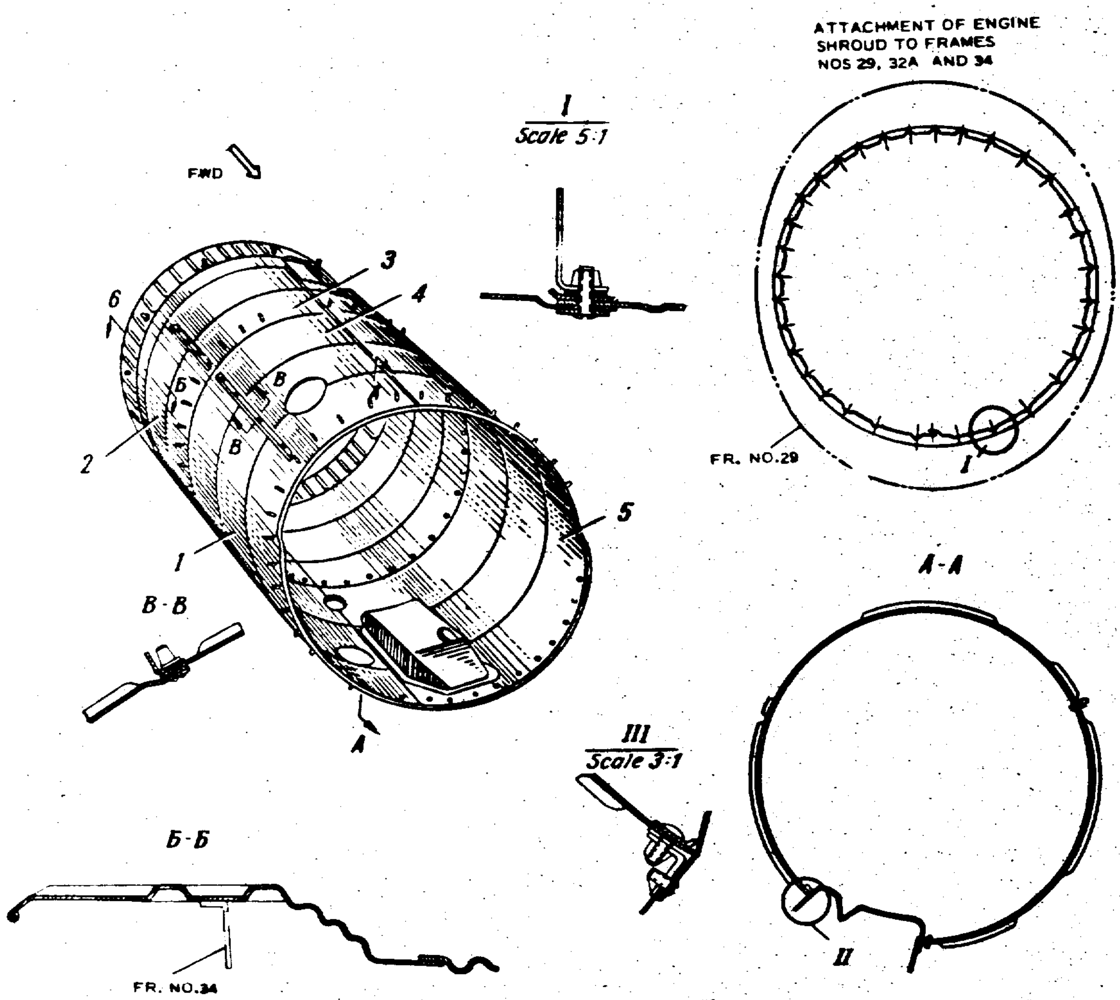

FIG.17. ARRANGEMENT OF ENGINE SHROUD AT FRAMES NOS 29 TO 34

1, 2, 3, 4, 5 – SHROUD SHEETS

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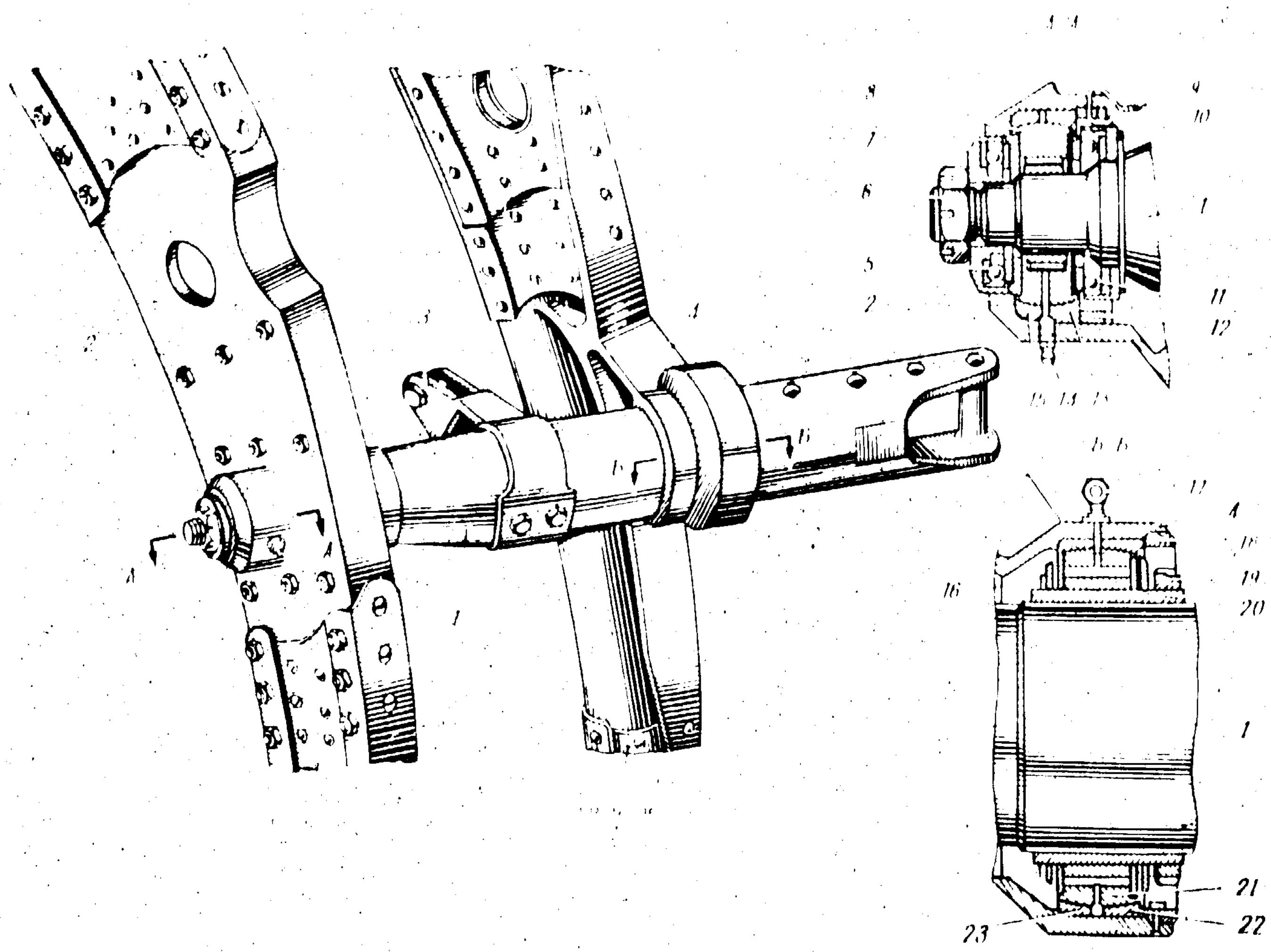

FIG. 19. ARRANGEMENT OF STABILIZER BEAM

[illegible] bearing, 12 — nut, 13, 14 — ring, 15 — grease fitting, 16 — lock ring, [illegible] grease fitting [illegible] bearing

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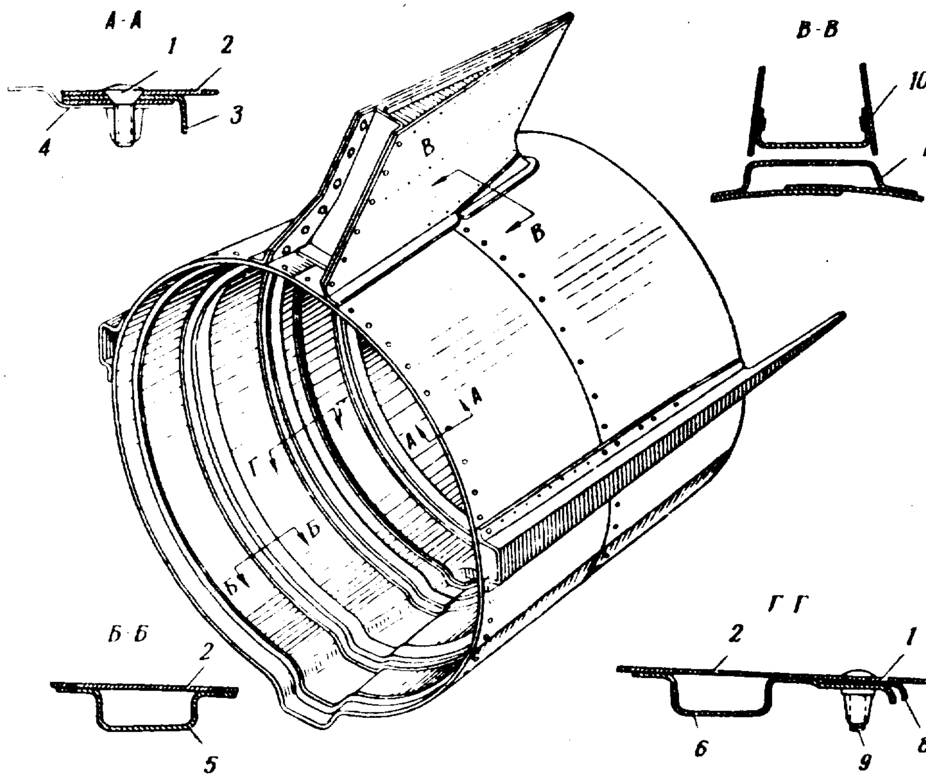


FIG.19. TAIL CONE CONSTRUCTION

1 – bolt; 2 – skin; 3 – shape, 4 – ribbon; 5 – shape; 6 – shape; 7 – skin; 8 – shape; 9 – bolt; 10 – superstructure; 11 – shape.

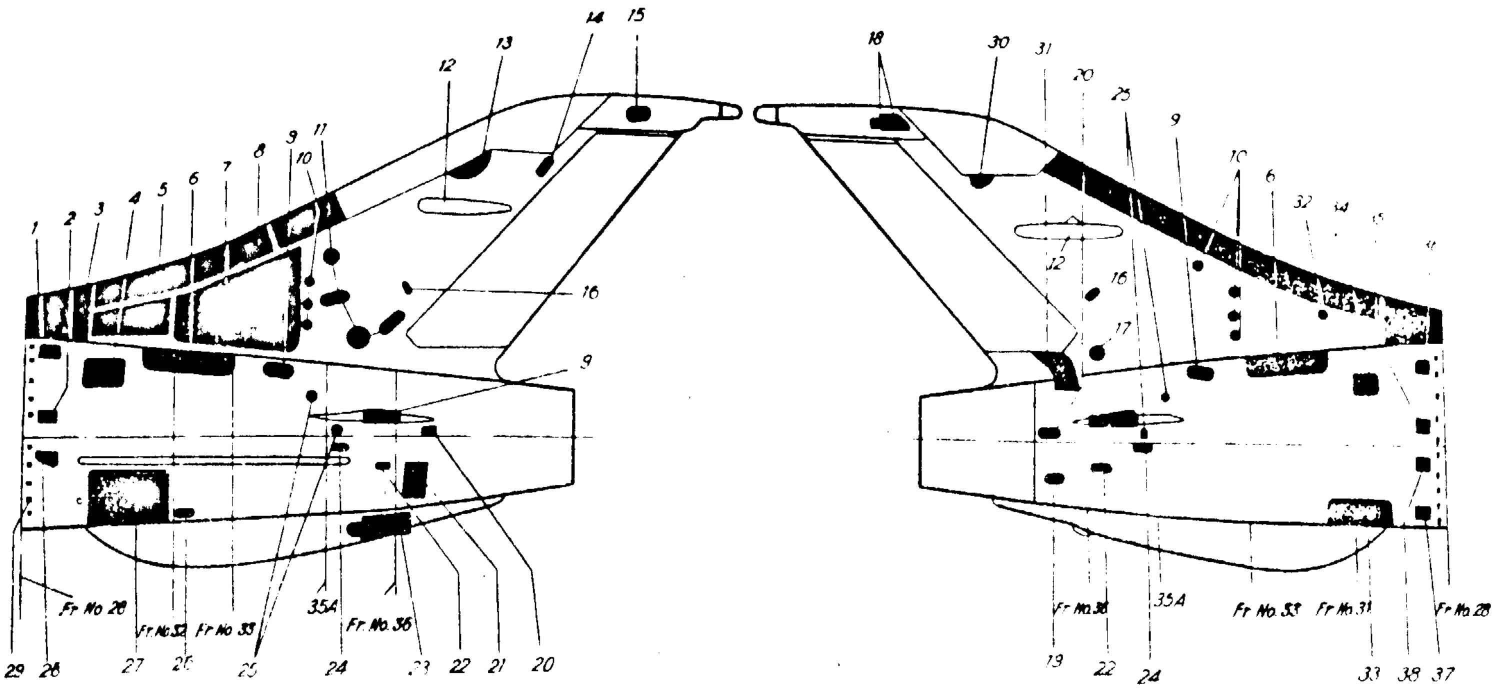


FIG.20. ARRANGEMENT OF SERVICE HATCHES IN FUSELAGE TAIL SECTION

1 – filling of hydraulic reservoir; 2 – kerosene pipeline connection; 3 – АРУ-3В automatic unit; 4 – thermocouple; 5 – artificial feel mechanism; 6 – booster system hydraulic accumulator; 7 – marker receiver, stabilizer angle pick-up; 8 – radio wiring attachment; 9 – stabilizer control bellcranks; 10 – booster attachment; 11 – rudder bell-crank; 12 – ДТ-2 pick-up; 13 – radio wiring attachment; 14 – rudder axle; 15 – antenna; 16 – fin hoisting lug; 17 – rudder bell-crank control; 18 – radio equipment unit; 19 – vent pipe joint; 20 – engine jet nozzle cylinder; 21 – jet nozzle hydraulic pipes; 22 – fastening of afterburner extension pipe support roller guides; 23 – drag chute lock; 24 – stabilizer beam grease fitting; 25 – stabilizer control bellcrank (fastening bolts); 26 – telescopic joint venting; 27 – drag chute, thermocouple; 28 – detachable hydraulic valves; 29 – jointing bolts on frame No. 28A; 30 – radio wiring; 31 – rudder control bell-crank; 32 – МРП-56П marker receiver plug; 33 – МРП-56П marker receiver antenna; 34 – thermocouple; 35 – safety valves of fuel tank pressurization system; 36 – filling of hydraulic reservoir; 37 – arrangement of engine generator blowing branch pipe; 38 – detachable hydraulic valves.

АТИМС-10 ВТУ No.С-1-57 covered with heat-resistant cloth НТ-7 ВТУ-СКО-2. At the stabilizer beam control bell-crank there are mounted bag-type heat-resistant covers made of material КТ-11 ВТУ-13-59.

Under the fuselage from frame No.28A up to the fuselage end there passes a ventral fin arranged along the axis of symmetry. The front removable part of the ventral fin is radio-transparent, being made of glass textolite. It is fastened to the ventral shapes by means of screws and self-locking nuts. The rear part of the ventral fin is metal and is fastened to the ventral shapes by a riveting seam.

Installed in the rear part of the ventral fin behind frame No.36 is the drag chute lock. The radio-transparent part of the ventral fin at frames Nos 31-32 mounts the antenna of the radio line, type BARIY, and a radio-frequency connector.

Inside the fuselage the space between frame No.29 and frame No.34 is occupied by the engine shroud (Fig.17). The corrugated shroud is made removable.

The engine shroud is secured by means of screws and anchor nuts along the inner contour of the fuselage tail section frames. The screws are installed on graphite grease, type УССА.

The stabilizer is mounted on axles rotating in the bearings arranged on frames Nos 35A and 36 (Fig.18).

Each part of the stabilizer is attached to a steel axle of round section by means of four vertical bolts and one horizontal bolt (Fig.16, III, sections Ж-Ж, E-E).

The stabilizer axles rotate in the supports of frames Nos 35A and 36 on the left- and right-hand sides. Each axle support on frame No.35A consists of three bearings - front 5 and rear 11 thrust bearings and one thrust-roller bearing 8. The support on frame No.36 is thrust-roller bearing 22. To eliminate radial play of the axles the bearings at frame No.36 are installed on bevel cut sleeve 20.

Longitudinal and radial plays of each axle are taken up by tightening the bearing nuts.

The fin is jointed to the fuselage by attachment fittings at frames Nos 34 and 36 (Fig.30).

The afterburner of the engine is attached at frame No.36.

To cool the engine, frame No.31A is provided with special air intake ducts.

The fuselage tail section ends in a removable tail cone (Fig.19). The tail cone is made of heat-resistant stainless steel and consists of two parts: front part and end attachment. Jointing of skin 2 of the front part of the tail cone and skin 7 of the end attachment is shown in section Г-Г. The end attachment is secured to the tail cone front part by means of bolts 9.

The tail-to-nose joint is sealed with rubber. The inner space of the fuselage tail section is made air-tight with sealing varnish applied to the sockets under the hatch covers.

For arrangement of service hatches in the fuselage tail section see Fig.20.

III. WING

General (Fig.21)

The wing of the aircraft is made triangular with a sweepback angle along the leading edge equal to 57°. The trailing edge of the wing forms a 90° angle with the fuselage axis.

The wing aerofoil is of high speed performance symmetric section.

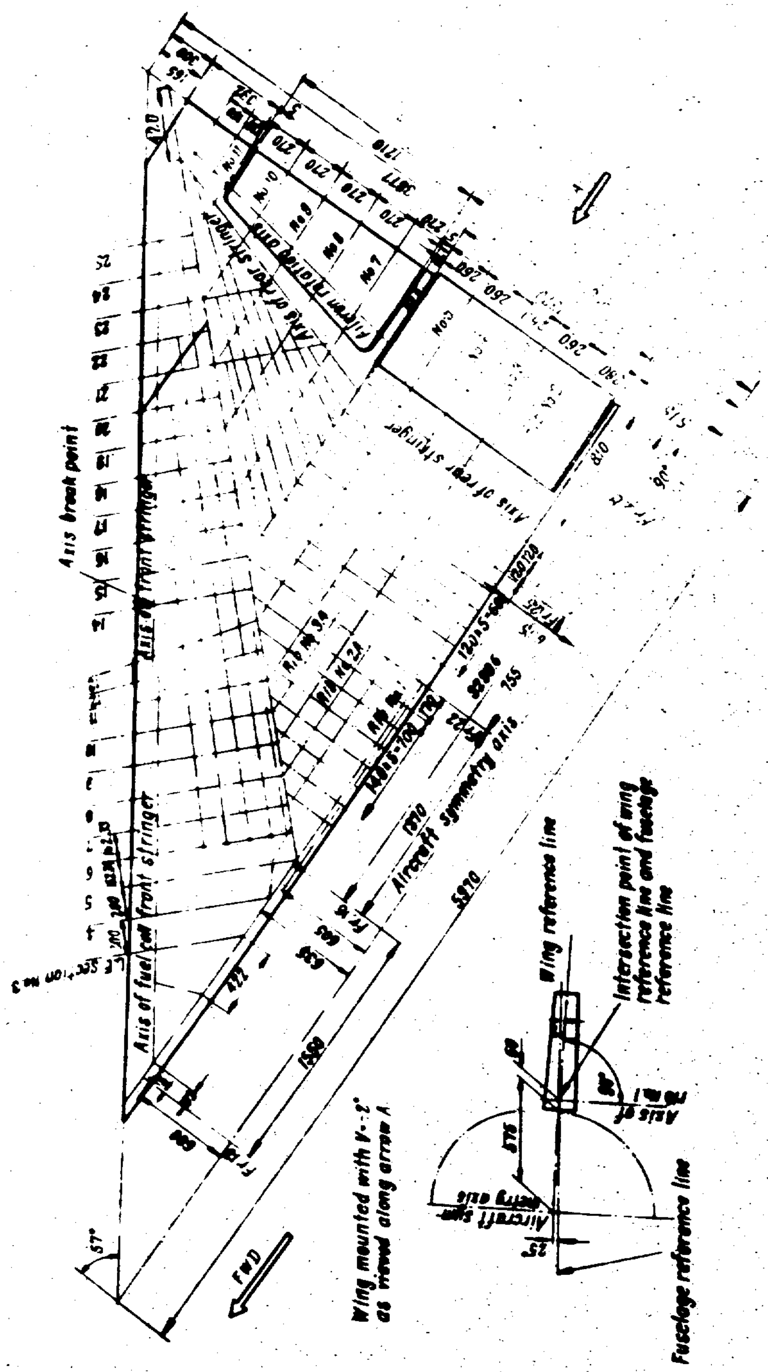


FIG.21. WING GEOMETRICAL DIAGRAM

Basic Geometric Data of the Wing:

Area	23 sq.m.
Span (inner wing included)	7.154 m.
Chord along aircraft axis	5.97 m.
Setting angle	0^{o}
Dihedral	2^{o}

Mounted on the wing are flaps having 2x0.935 sq.m. area and pressure-balanced ailerons having 2x0.59 sq.m. area.

The upper surface of every outer panel of the wing bears one aerodynamic fence. The fences are intended to improve the fore-and-aft stability of the aircraft at great angles of attack.

The projecting parts of the wing are protected with fairings: the aileron bell-crank fairing which is mounted on the upper surface of the wing and the flap tail fairing located on the lower surface of the wing.

1. Wing Structure
(Fig.22)

The wing is made up of two outer panels. The frame of every panel includes one spar, two web stringers (front and rear), main beam, rear wall of the rear tank compartment, rib assembly, skin and skin stiffening stringers.

Main materials of the wing structure are: duralumin Д16, alloy B95, steels 30ХГСНА and 30ХГСА, alloys МЛ5-Т4 and ВМ65-1.

Every outer panel has a well between the spar and the main beam for retraction of the main L.G. strut.

Every outer panel of the wing is constructed so as to accommodate two fuel tanks, one tank being located in the nose portion of the wing and the other, in the centre butt portion of the wing.

The centre portion of each outer panel mounts an aileron control booster, while the butt portion mounts oxygen bottles.

Arranged on the left and right outer panels in the butt portion of the spar and main beam are transportation units, while on the right outer panel of the wing, in front of the main beam between ribs 1 and 2, a small-size landing light.

The outer panel tips at ribs 13 and 15 mount two units for special loads. The wing is fastened to the fuselage at five points.

The wing spar is composed of three portions: butt portion, centre portion and tail portion. The butt portion of the spar has a seat to accommodate the thrust bearing of the rotation axle of the main L.G. strut.

The front stringer is of variable section: it is stamped in the butt portion, has a special section at the tank compartment, and has the channel section between rib 12 and rib 26.

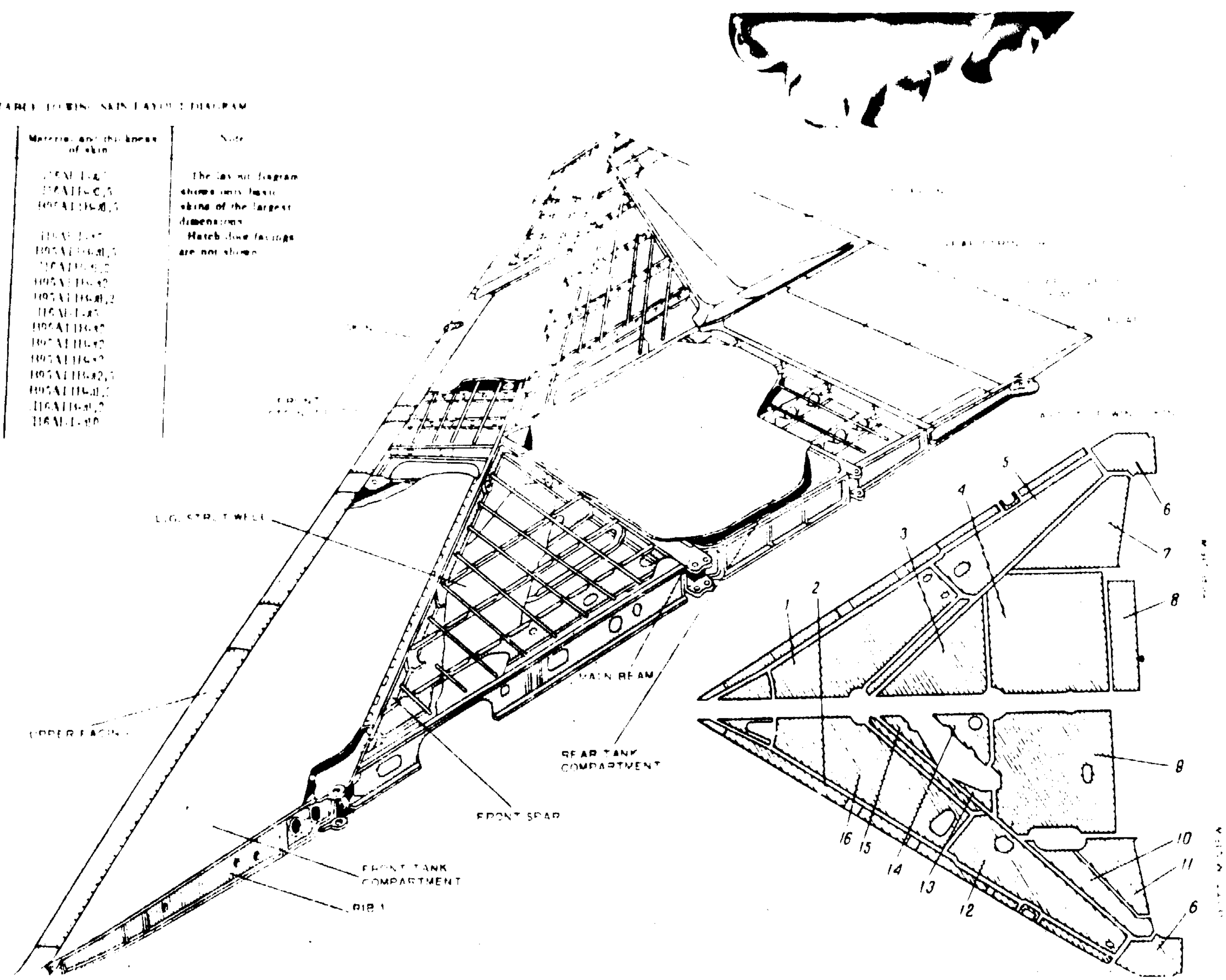
The rear load-carrying stringer is made up of two portions joined together with the aid of an insert on rib 6. The stringer portion between rib 4 and the wing tip is reinforced with plates from top and bottom.

The main beam is swaged of steel. For obtaining the required outer contour, there are gaskets placed along the beam upper and lower surfaces and sawed over the wing contour. The main beam is provided with one more seat for accommodating the thrust bearing of the main L.G. strut rotation axle.

The ribs are fabricated mainly of sheet material Д16.

TABLE TO WING SKIN LAYOUT DIAGRAM

No. in diagram	Material and thickness of skin	Note
1	[illegible]	The layout diagram shows only basic skins of the largest dimensions. Hatch door facings are not shown
2	[illegible]	
3	[illegible]	
4	[illegible]	
5	[illegible]	
6	[illegible]	
7	[illegible]	
8	[illegible]	
9	[illegible]	
10	[illegible]	
11	[illegible]	
12	[illegible]	
13	[illegible]	
14	[illegible]	
15	[illegible]	
16	[illegible]	



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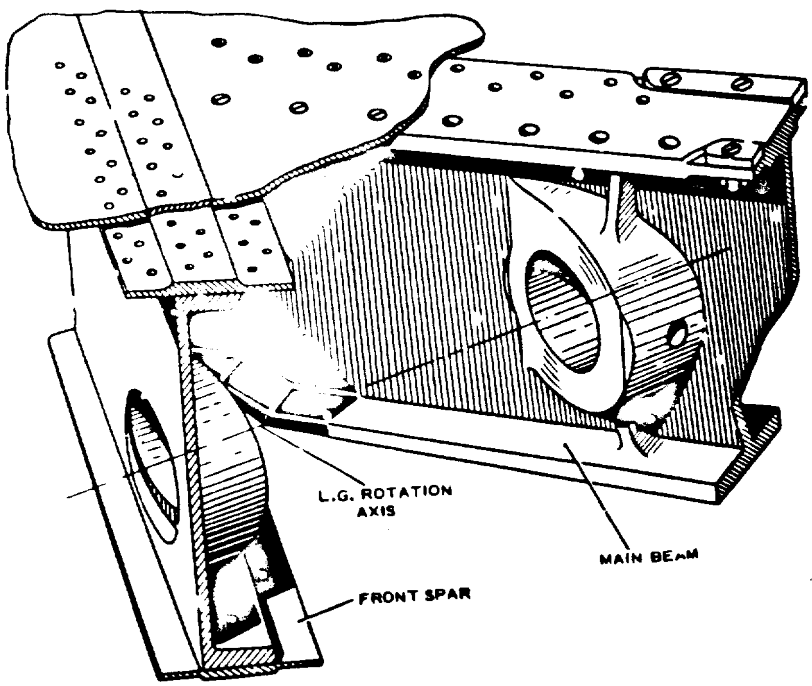
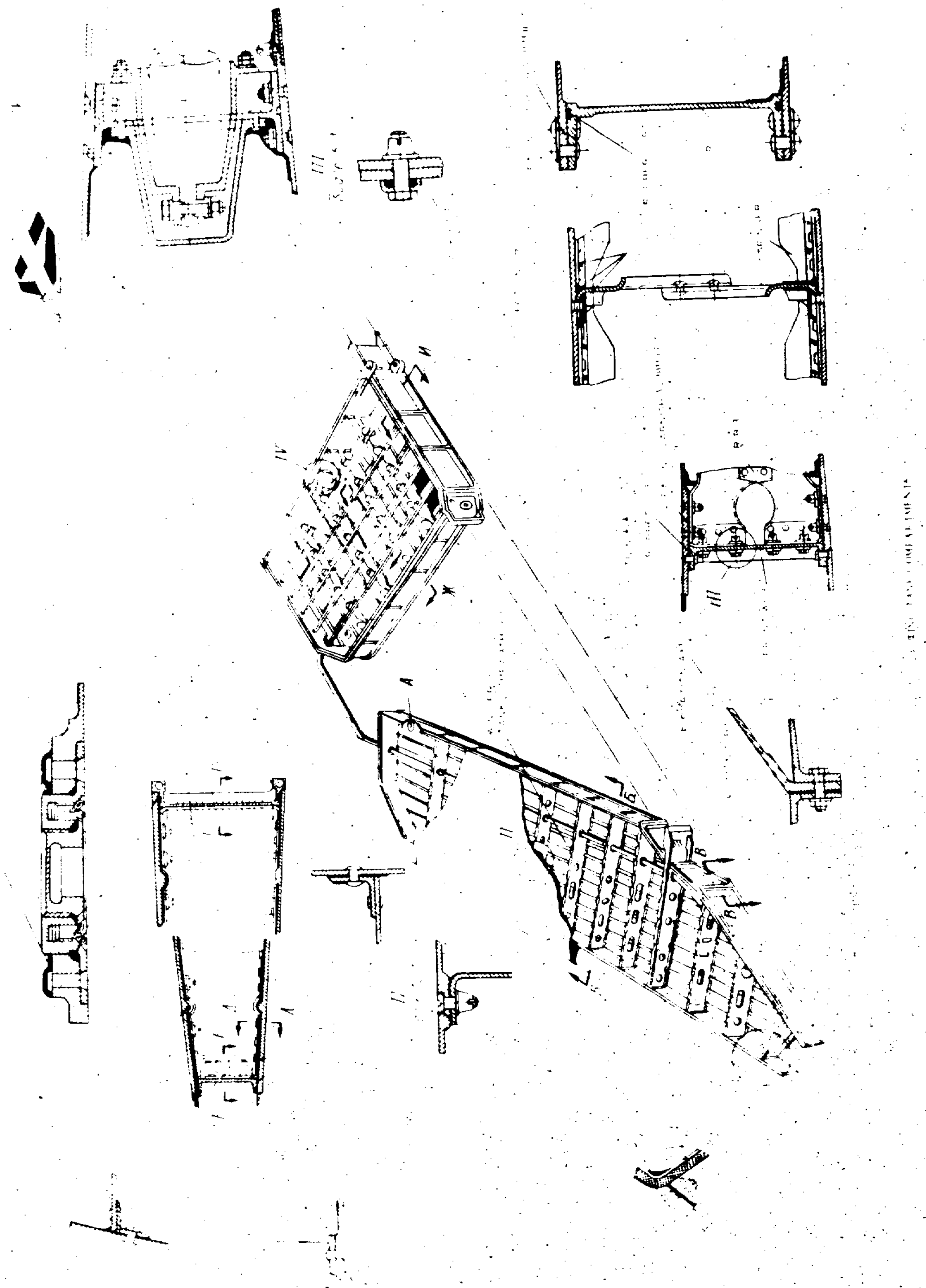


FIG.23. L.G. MAIN STRUT ATTACHMENT UNIT

25X1



25X1

25X1

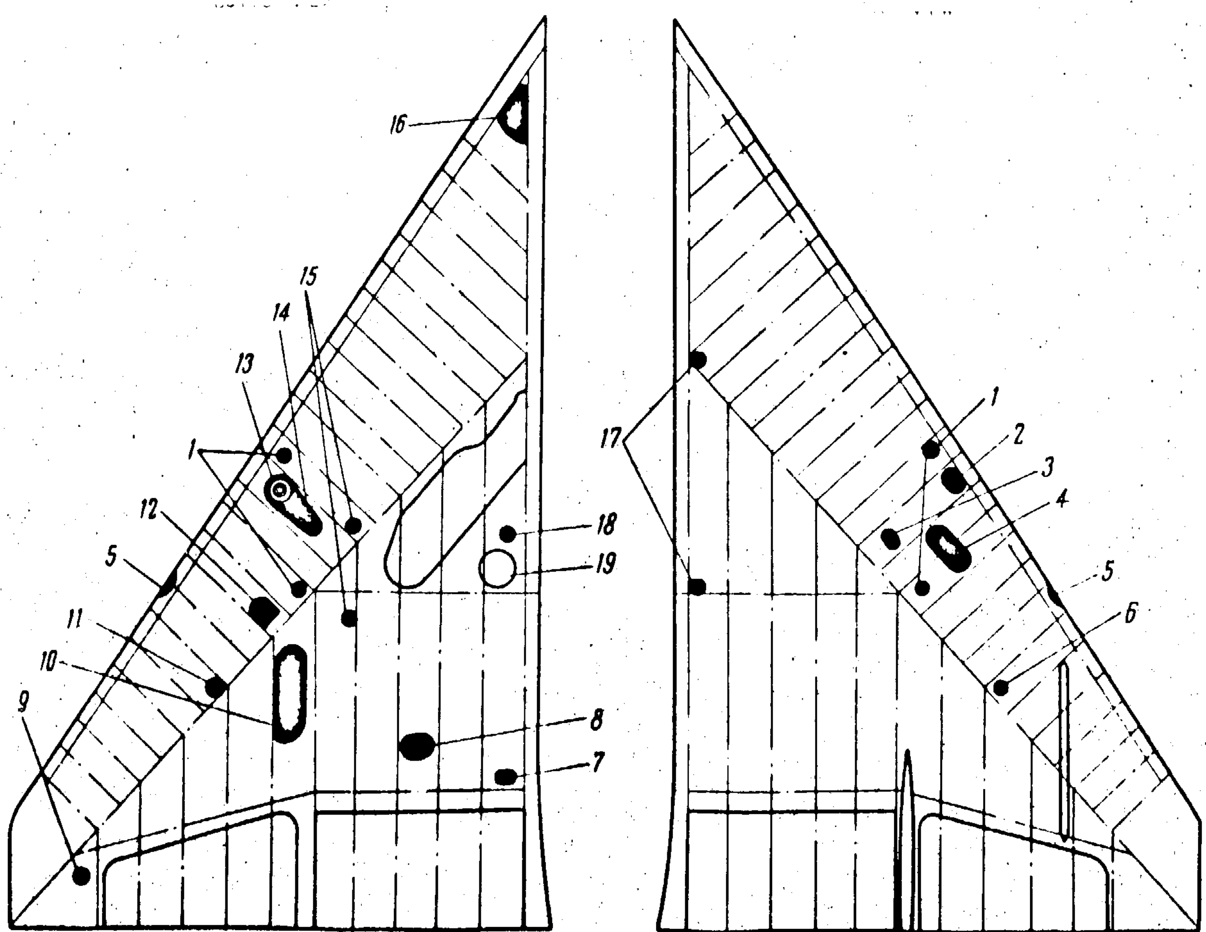


FIG.25. ARRANGEMENT OF SERVICE HATCHES IN WING

1 – special stores beam units; 2 – electric connections; 3 – L.G. strut axle, HNC-36; 4 – fuel pipeline; 5 – navigational lights; 6 – hoisting lug; 7 – flap limit switch connector; 8 – flap cylinder; 9 – aileron axle; 10 – booster; 11 – pad for trestle; 12 – aileron control bell-crank; 13 – special stores beam electric connection; 14 – L.G. axle; 15 – fuel drain; 16 – aileron control bell-crank, electric connection; 17 – hoisting lug; 18 – locking screw of landing light motor; 19 – landing light.

25X1

The ribs arranged in the centre and tail portions of the wing are manufactured of materials Д16Т, АК-6, В-95, МЛ5-Т-.

The ribs are cut to fit the stringers. The stringers are cut in the centre portion of the wing along rib 6 and joined together with the aid of a joint bar and eyelets.

The rib L.E. sections are arranged perpendicular to the spar of the wing and are also provided with cuts to fit the longitudinal stiffening bars on the panels of the front tank compartment.

The wing skin is made of material В-95. The skin portion in the vicinity of the nose and tail fuel tank compartments on the upper and lower surfaces is made of sheet Д16АТ.

Wing Fuel Tanks

Each outer panel of the wing carries two fuel tanks. The front fuel tank compartment is arranged in the area of the L.E. sections of ribs 1 to 13. The rear fuel tank compartment is located in the area of the main beam and ribs 1 to 6. The rear wall of the tank passes along the continuation of the axis of fuselage frame No.25. Every fuel tank is an airtight compartment formed by the structural members of the wing.

The front fuel tank compartment is formed by the L.E. sections of ribs 1 to 13, front stringer, longitudinal web, and upper and lower panels. Inside the tank are arranged rib-type sections forming the transversal load-carrying structure of the wing, which at the same time serve as the bulkheads of the tank.

The rear fuel tank compartment is made up of the front wall, rear wall, ribs stringers and two (upper and lower) panels.

Airtight integrity of the tanks and corrosion protection of their inner surfaces are ensured by laying sealing varnish on glue. Prior to riveting and fitting the bolts, the lugs and members of the tank frame to be joined together and contiguous to the skin are coated with the sealing varnish applied over a layer of glue.

A rubber cord is put in the groove under the upper skin (panel).

After the final assembly the tank compartments are tested for airtightness: kerosene compressed to 0.6 kg/cm^2 excess pressure during 20 minutes, and for strength, by kerosene compressed to 0.9 kg/cm^2 (in the case of tank No.2) or to 1 kg/cm^2 (for tank No.1) during 3 to 5 minutes.

Wing Attachment Units

The outer panels of the wing are secured to frames Nos 13, 16, 22, 25 and 2[illegible] of the fuselage. The attachment units of the wing are: forward load-carrying stringer, spar, main beam, rear wall of the tank compartment and the wing rail of the flap.

The forward load-carrying stringer is attached to frame No.13 by one bolt of 6 mm diameter.

The spar is secured to frame No 16 by means of two vertically set bolts of 22 mm diameter, and one horizontally set bolt, of 16 mm diameter.

The main wing-to-fuselage attachment unit is arranged on frame No.22 along the main beam, the locking being ensured by two bolts of 30 mm diameter.

The rear wall of the rear fuel tank compartment is secured to frame No.25 by one bolt of 18 mm diameter.

The flap rail is fastened on frame No.28 with the aid of a 12 mm dia. bolt.

Aileron (Fig.26)

The aileron is located in the rear portion of the wing limited by the rear stringer, rib 6 and the tip of the wing.

The aileron is of riveted construction. Its framework is made up of front and rear spars, rib assembly, upper and lower skins and a limit edge shape used as a ...n-controlled trim tab on the left aileron.

Mounted in the front portion of the aileron is an antiflutter weight cast of steel and shaped to fit the contour of the aileron.

The spars and ribs are made of sheet material Д16АМ.

The aileron skin portions (upper and lower) are made solid of variable section: 1.5 mm in the front part up to the rear spar and 0.8 mm in the rear spar.

The aileron is suspended at three points: the first butt point, or bearing point, is located on rib 6 (with the control rod coming to it), the second centre point - on rib 9, and the third butt point on the wing tip.

The area of the aileron runs into 2x0.59 sq.m., the deflection angles are within $\pm 20°$, the aerodynamic pressure balance is about 24% of the chord line length.

Flaps

The wing has floating flaps with a maximum deflection angle of 24° (Fig.27).

The flap is made up of two spars and a set of ribs.

The flap is hinged to the wing outer panel on two rails located at the flap end faces between ribs 1 and 6.

The rail closer to the fore-and-aft axis of the aircraft mounts a limit switch of the retracted position of the flap. Inside the rails are arranged rims.

Carriages (two on each side) which are axles with rollers are set at both end faces of the flap. The front carriage has a pin with a roller and a thrust bolt, while the rear carriage is fitted with two rollers and two thrust bolts taking up side loads. The flap actuating hydraulic cylinder is fastened in the middle part of the wing outer panel between ribs 3 and 4.

IV. TAIL UNIT

(Figs 28 - 31)

General

The sweptback tail unit of the aircraft is of the cantilever type. It is comprised of horizontal and vertical stabilizers and has a symmetric profile.

The plan view of the horizontal stabilizer yields 55° angle of sweepback.

The area of the control surface is 3.94 sq.m., the angle of stabilizer setting is 0° and the dihedral V is 0°, too.

Angles of stabilizer deflection:

(a) forward:

leading edge upward .... +7°30'

leading edge downward .... -16°30'

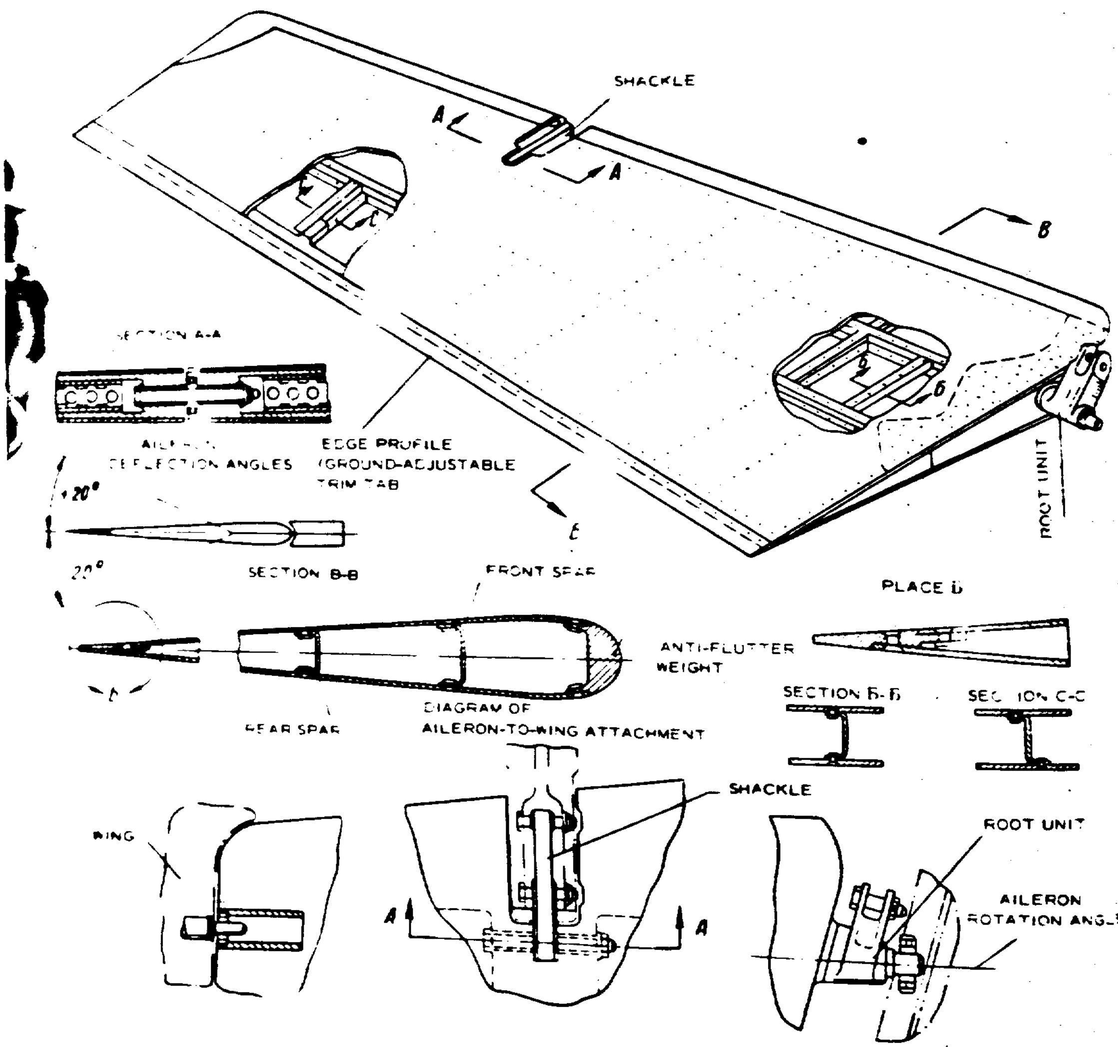


FIG. 26. AILERON

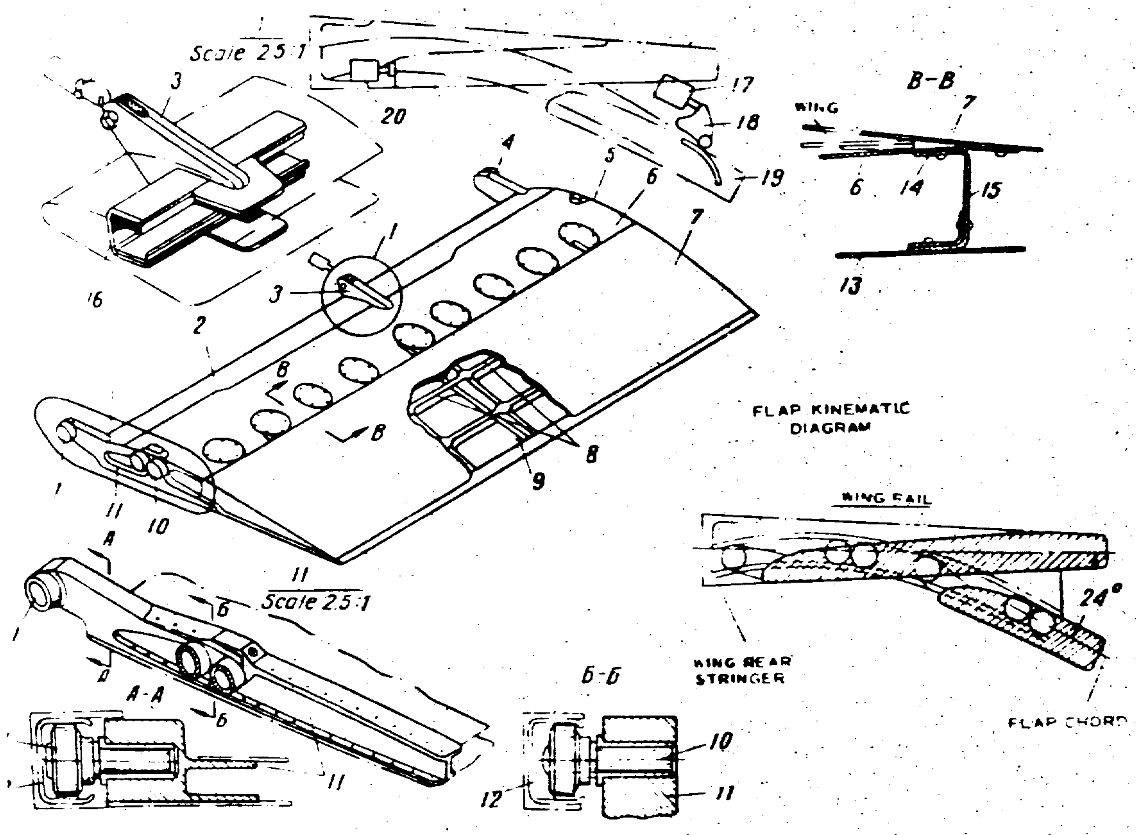
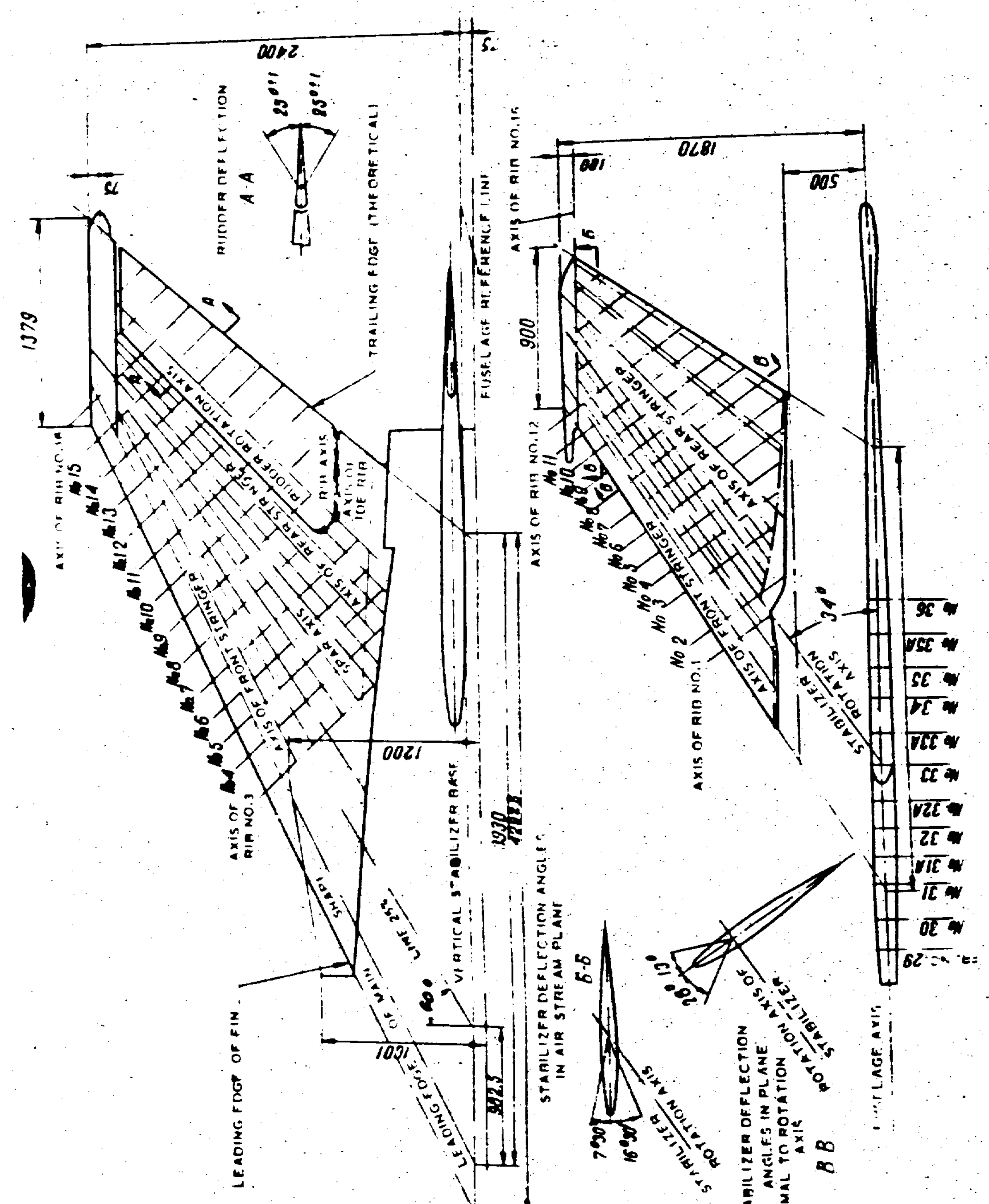


FIG.22. FLAP

1 – carriage; 2 – nose portion skin; 3 – flap actuating cylinder rod attachment unit; 4 – carriage; 5 – carriage; 6 – skin; 7 – skin; 8 – shape; 9 – rib; 10 – carriage; 11 – bracket; 12 – wing rail; 13 – skin; 14 – insert; 15 – rear spar; 16 – front spar; 17 – flap extension warning microswitch; 18 – bell-crank with roller; 19 – shape; 20 – flap retraction warning microswitch.

 25X1


2400
RUDDER DEFLECTION
A-A
1870
180
500
1379
900
TRAILING EDGE (THEORETICAL)
FUSELAGE REFERENCE LINE
AXIS OF RIB NO.16
RUDDER ROTATION AXIS
AXIS OF REAR STRINGER
AXIS OF FRONT STRINGER
SPAR AXIS
AXIS OF RIB NO.12
AXIS OF RIB NO.1
AXIS OF RIB NO.3
1200
VERTICAL STABILIZER BASE
STABILIZER ROTATION AXIS
34°
LEADING EDGE OF FIN
STABILIZER DEFLECTION ANGLES IN AIR STREAM PLANE
Б-Б
STABILIZER DEFLECTION ANGLES IN PLANE NORMAL TO ROTATION AXIS
B B
FUSELAGE AXIS

25X1

(b) normal to the rotation axis with the booster engaged:

leading edge upward .... +13°

leading edge downward .... −26°

The vertical stabilizer is designed to ensure maximum stability of the aircraft in the fore-and-aft direction at high speeds. For this purpose the fin leading edge is made longer and pointed.

The vertical stabilizer area sizes 4.57 sq.m. and its angle of sweepback is 60°, its profile being made symmetrical.

The pressure-balanced rudder has an area of 0.965 sq.m. The maximum angles of rudder deflection rightwards and leftwards reach 25°.

1. Horizontal Stabilizer

The controlled horizontal stabilizer of the aircraft has no elevator.

The stabilizer is made up of two halves (Fig.29).

Each half of the stabilizer includes a front web stringer coming in two parts (the front part and the rear variable-section part), two load-carrying beams, a set of ribs, rear variable-section stringer, two front facings, a facing of the leading edge and a tip with an antiflutter weight, two fairings, two stressed plates and a tail section.

The tail section is made up of Z-section ribs, two angular stringers and a trim tab with a bend angle upward of 4°.

2. Vertical Stabilizer

The vertical stabilizer is comprised of the fin and rudder.

Fin

The fin is made (Fig.30) of lateral framework of stamped sheet ribs and rib 5, two load-carrying web-type stringers (the front and the rear ones), longitudinal framework of pressed stringers, butt end rib, beam and skin of variable section.

The fin is attached to the upper panel of the fuselage tail section by means of units mounted on frames Nos 34 and 36, and riveted to steel sheet angle bars along the contour.

The rudder is secured to the fin at three points.

The ribs of the fin are set normal to the axis of the fin spar. The webs of the ribs are cut out to pass the stringers stiffening the skin. The front stringer of the fin is made up of variable-thickness sheets.

The rear stringer comes in two portions: the butt one (the joint unit) and the end one of variable thickness.

The fin beam is attached to frame No.34 along its butt portion. On the beam is installed the stabilizer control booster. The fin skin is made of sheet material Д15 of variable thickness.

The fin tip is of riveted construction and mounts radio equipment units and the tail navigation light. The centre portion of the fin also mounts radio equipment units. The root portion of the fin is provided with service hatches (Fig.20), the forward skin of the fin being made removable.

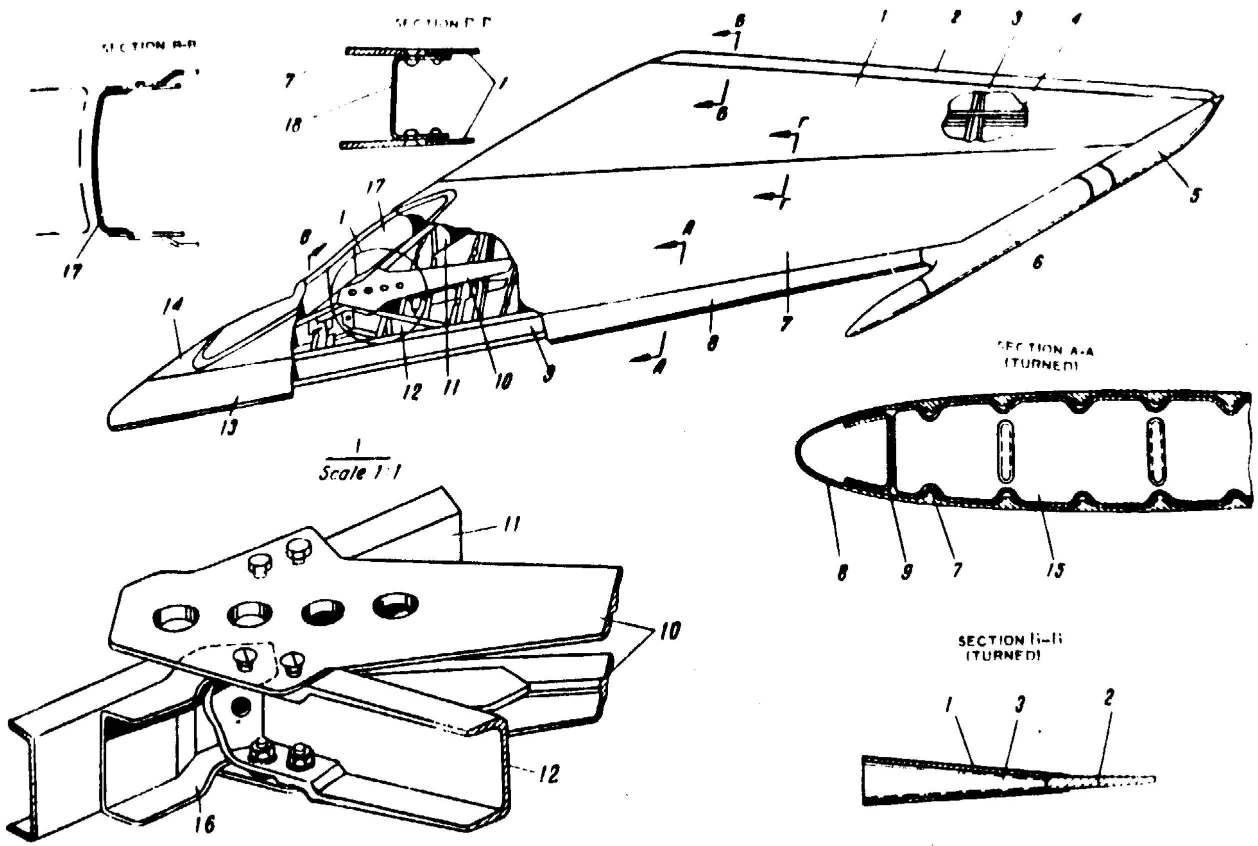


FIG.29. STABILIZER

1 – skin; 2 – trim tab; 3 – rib; 4 – stringer; 5 – tip; 6 – anti-flutter weight. 7 – skin; 8 – nose portion skin; 9 – front stringer; 10 – plate; 11 – beam; 12 – beam; 13 – nose portion skin; 14 – skin; 15 – rib; 16 – bow; 17 – butt-end rib; 18 – rear stringer.

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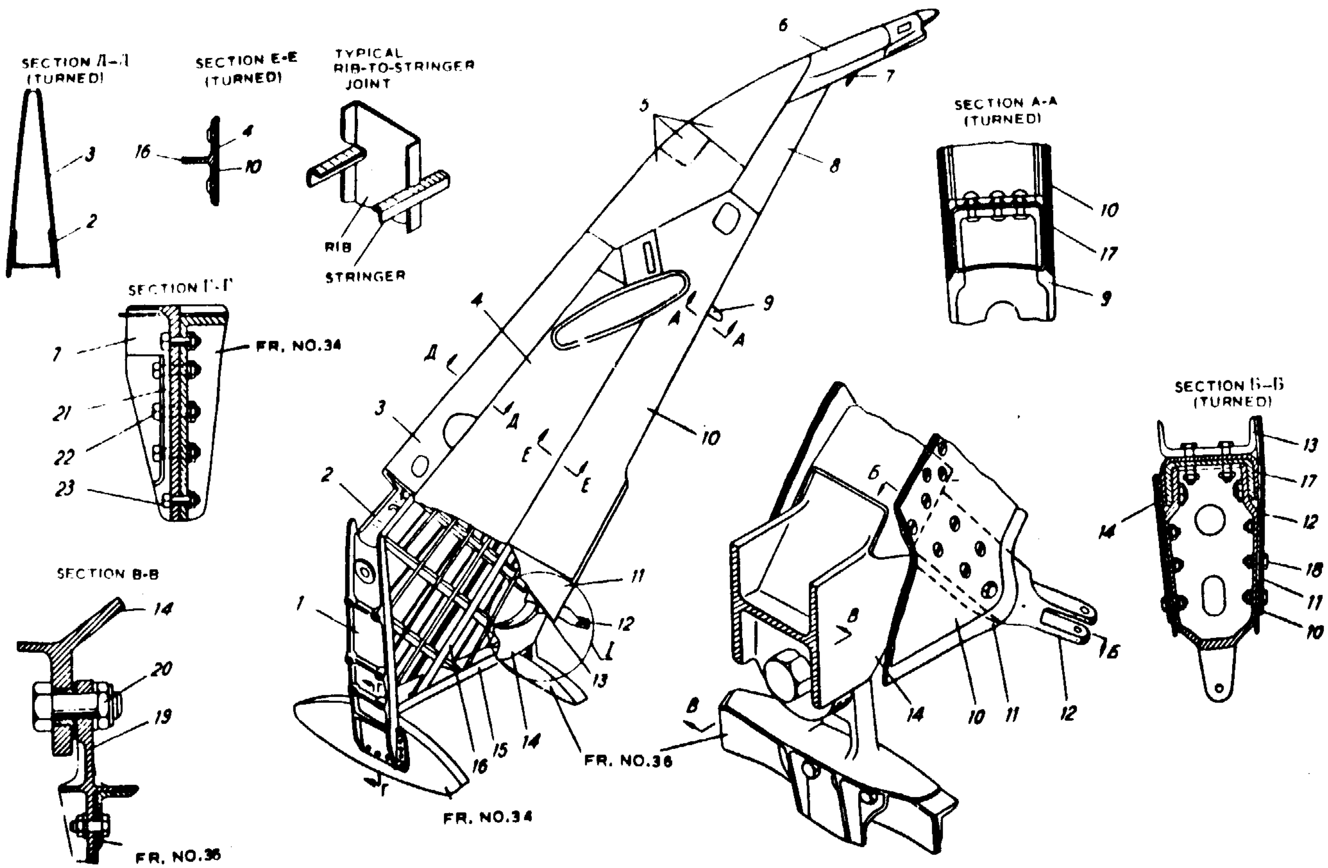

FIG.30. FIN

1 – fin beam; 2 – front stringer; 3 – nose portion skin; 4 – skin; 5 – skin; 6 – fin tip; 7 – rudder upper attachment unit; 8 – skin; 9 – rudder middle attachment unit; 10 – skin; 11 – stiffener; 12 – rudder lower attachment unit; 13 – bracket; 14 – root unit; 15 – butt rib; 16 – spar; 17 – rear stringer; 18 – bolt; 19 – frame unit; 20 – jointing bolt; 21 – washer; 22 – bolt; 23 – bolt.

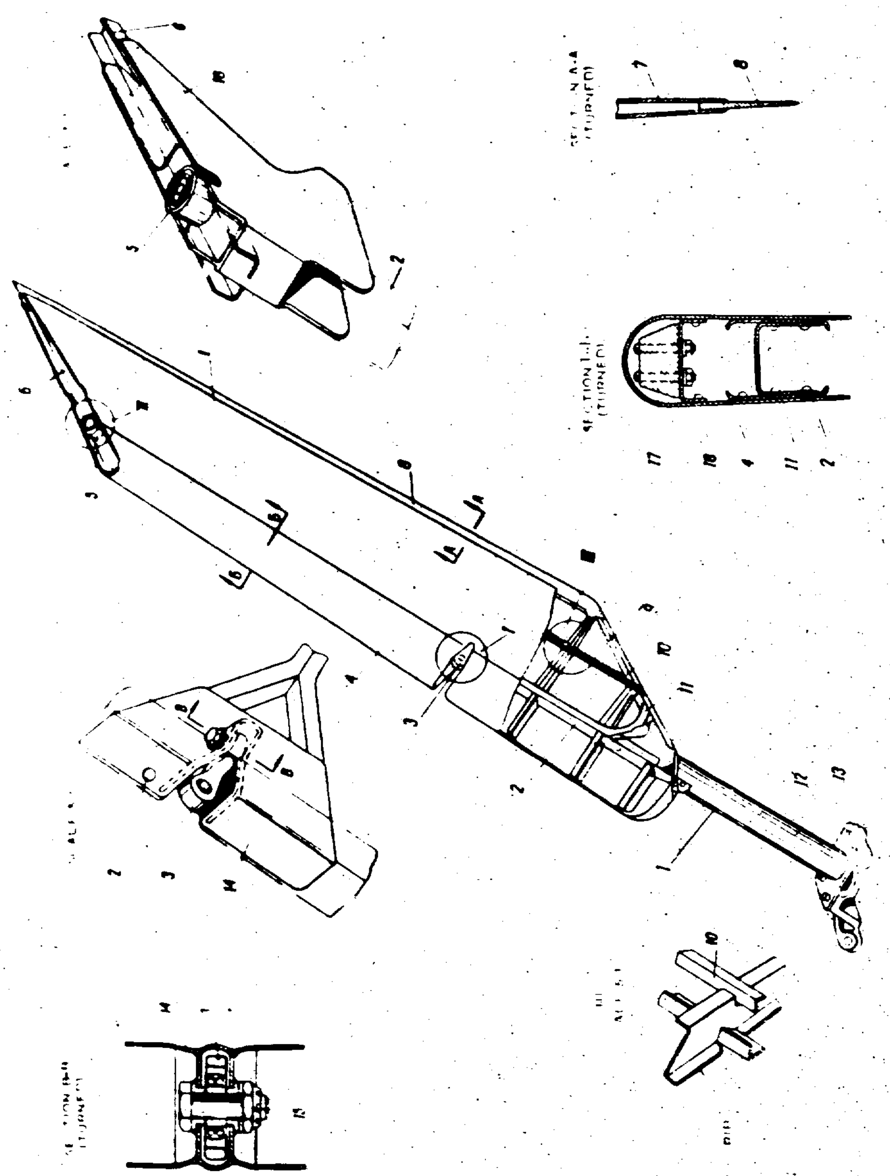

FIG.31. RUDDER

1 – tube; 2 – spar; 3 – shackle; 4 – nose portion skin; 5 – upper unit; 6 – rib web; 7 – skin; 8 – trim tab; 9 – butt-end rib; 10 – stringer; 11 – stiffener; 12 – flange; 13 – bell-crank; 14 – unit; 16 – upper unit; 17 – anti-flutter weight; 18 – web.

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Rudder (Fig.31)

The rudder is of riveted construction; it is made of two spars, two stringers, ·ib assembly, skins and three attachment units.

Arranged in the front part of the rudder between ribs 11 and 17 are antiflutter eights.

The trailing portions of the rudder are provided with a trim tab to regulate ne stability of the aircraft in flight.

Chapter III

POWER PLANT

GENERAL

The aircraft is powered by jet engine 37Ф2 with the afterburner and variable area all-duty nozzle (Fig.32).

The engine is installed inside the fuselage. The air is taken through the nose air intake with the adjustable cone and delivered to the engine via two ducts which then form one common inlet duct hermetically coupled with the engine. The air intake made in the nose portion of the fuselage accommodates automatically controlled anti-surge shutters; the non-controlled shutters to ensure air intake into the engine when operating on the ground are located between frames Nos 9 and 10.

To protect the aircraft structure and the units of the engine against overheating the compartment accommodating the engine and the afterburner is blown with the air supplied from the air intake duct through the ports of the air cooler when in flight, and from the atmosphere through the fuselage valves located in the zone of the engine when the engine runs on the ground. The valves mentioned above open in response to the rarefaction created at the jet nozzle edge as a result of ejection of gases.

The engine operates on kerosene.

The aircraft fuel is carried:

(a) in seven fuselage tanks;

(b) in two forward wing fuel tanks;

(c) in two aft wing fuel tanks;

(d) in one drop tank arranged on the pylon under the fuselage.

Maintenance of the required balance of the aircraft in flight and complete consumption of fuel from the tanks require that the fuel should be taken up in a definite order which is automatically ensured by special valves and float valves.

For ensuring a reliable fuel supply of the engine during flights at high altitudes, the fuel system is provided with special devices meant to pressurize the tanks from the engine compressor. It is also fitted with a vent system with a velocity head intake for quick building up of pressure in the tanks at diving.

The lower section of the third tank is a compartment ensuring fuel supply of the engine during short-time flights with the negative overloads or during short-time inverted flights.

Reliable starting of the engine in flight is ensured by the starting ignition oxygen supply system.

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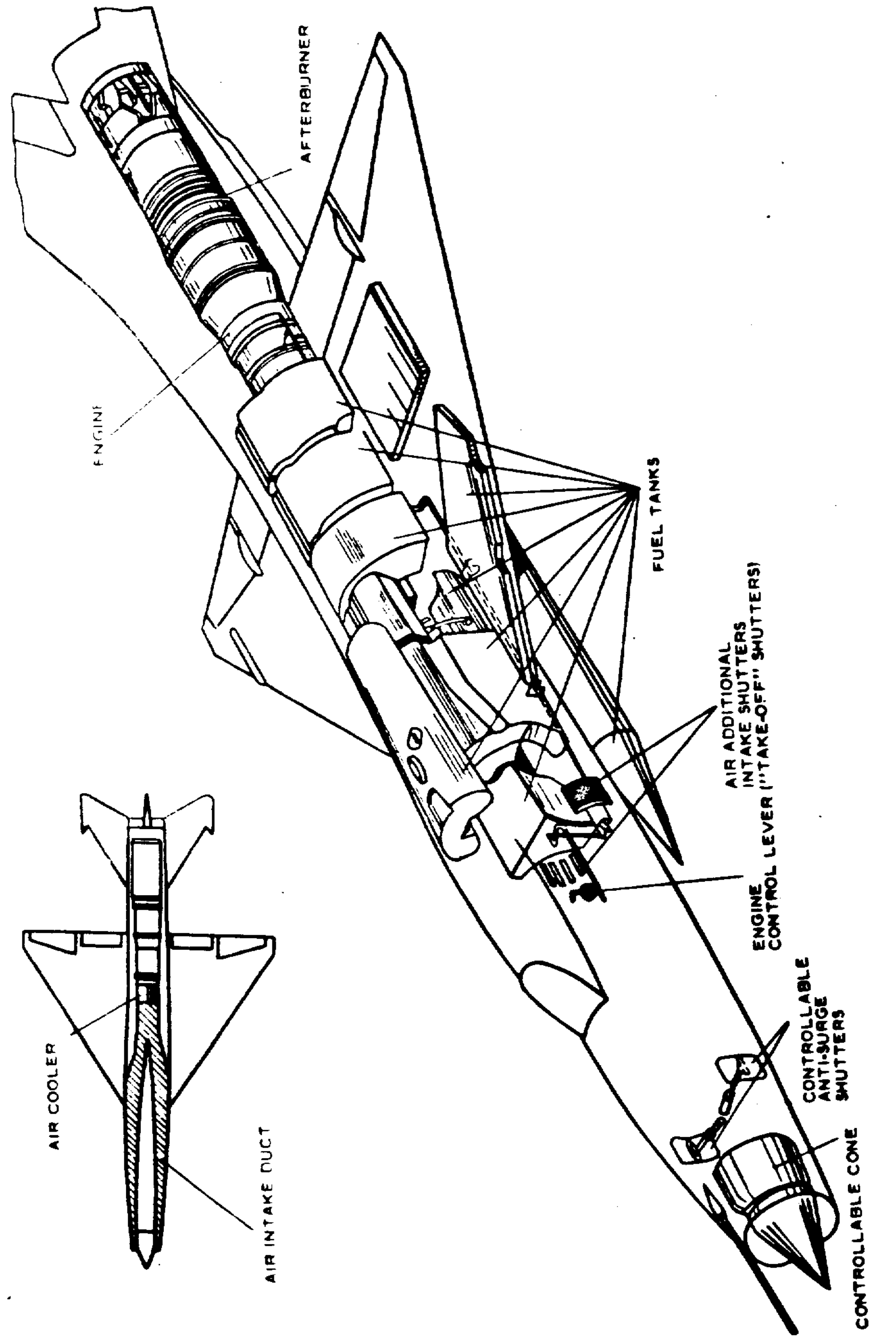

FIG.32. GENERAL VIEW OF POWER PLANT

25X1

The engine operation is governed with the aid of the engine control lever installed in the pilot's cockpit and connected to the engine control panel by means of the control rod-and-bell-crank system.

The engine drainage system is also provided in the aircraft for accumulating fuel from the engine spaces and for discharging it overboard.

The fire-fighting equipment mounted in the aircraft is intended for warning the pilot of fire in the area of the engine and for fighting it.

The fuselage of the aircraft is provided with special doors ensuring access to the engine units and service points when disjointing the aircraft or removing the engine.

Engine

Installed on the aircraft is a two-shaft engine [illegible] with axial six-stage, two-spool compressor, cannular combustion chamber and two-stage turbine.

The first three stages of the compressor are mounted on the shaft where the second stage of the low-pressure turbine rotor is arranged; the remaining three stages are mounted on the shaft carrying the first stage of the high-pressure turbine rotor.

The all-duty jet nozzle has a variable area. The area of the nozzle is changed automatically with the aid of controllable flaps.

The engine is equipped with:

1. Electric autonomous and automatic starting system ensuring starting of the engine by pressing one button.
2. Oxygen automatic supply-to-igniters system employed when restarting the engine in flight.
3. Fuel pump HP-2102 providing for the engine control and ensuring constant r.p.m. of the engine irrespective of the speed and altitude of flight.
4. Fuel pump HP-2202 intended to supply fuel to the afterburner when the flight is performed at augmented rating.
5. Engine control unit [illegible]-16 which together with the fuel pumps HP-2102 and HP-2202 ensures the engine control from the CUT-OFF (СТОП) position up to the full augmented rating by moving the engine control lever alone.
6. Follow-up system of the jet nozzle electrohydraulic control.
7. Self-sustained oil system which is comprised of the oil tank provided with a special fixture ensuring oil supply during inverted flight, fuel and oil cooler, pressure and scavenging pumps, filters, de-aerator and centrifugal breather.
8. Ignition system and electric equipment.

The engine wheelcase mounts the following units:

Generator-starter	
A.C. generator	ГСР-СТ-12000ВТ
Two hydraulic pumps	[illegible]
Fuel delivery pump	НП34-[illegible]
Tachometer generators	[illegible]-13-[illegible]
	ДТЭ-1

Arranged behind the last compressor stage are flanges for bleeding air to pressurize the pilot's cockpit, fuel tanks and hydraulic reservoir.

I. ENGINE ARRANGEMENT

1. Arrangement of Engine and Afterburner

The engine with the afterburner is mounted in the fuselage between frame No.Z and the rear end of the fuselage (Fig.33).

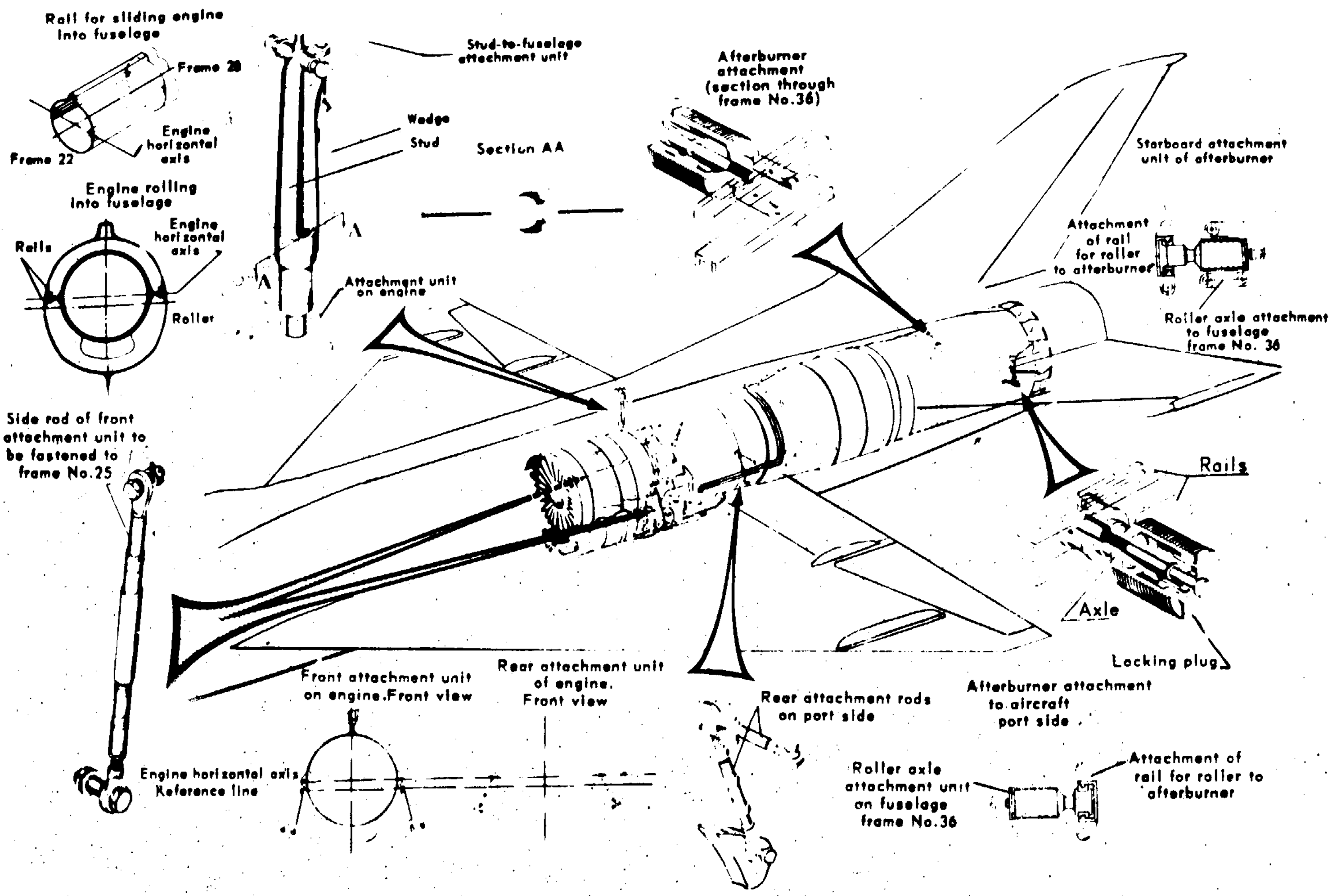

FIG.33. ENGINE AND AFTERBURNER ATTACHMENT

[redacted]

When viewed from above, the axis of the engine coincides with the axis of symmetry of the aircraft, while the outboard profile view shows that it runs some 90 mm above the reference line of the aircraft at frame No.28 and some 65 mm at frame No.32A.

In the plan view drawing, the axis of the afterburner forms a small angle with the engine axis as the rear portion of the afterburner is mounted so that the roller axis stands some 5 mm to the left of the aircraft axis of symmetry. When the engine is running, the thermal expansion causes the rightward shift of the afterburner till it is aligned with the engine axis.

When viewed sideward, the afterburner axis first slightly slopes down and then forms a gentle uptake from frame No.34 to the edge of the jet nozzle.

Engine Fastening

The engine is provided with two attachment units: the front (the main one) on frame No.25 and the rear one on frame No.28.

The front attachment unit is accommodated in the plane close to the engine centre of gravity. It includes an upper assembly and two side rods. The upper assembly takes the thrust of the engine and is loaded up by the side forces.

The load-carrying member of the upper assembly is the bar terminating in a pin which during the assembly enters the ring having a spherical surface and secured to the engine.

The bar is attached to the upper beam of the fuselage at two points: to the upper wing of the beam (with the aid of a chromansil bolt, 10 mm in dia.), and to the lower wing of the beam (pressed by means of steel wedge).

The bar-stud-to-engine connection allows free movement of the engine in the vertical plane and the turn thereof relative to the spherical surface during thermal expansion or levelling of the engine.

The side control rods are meant for taking over compression and expansion and vertical loads. The rods are made of chromansil steel; their upper portions are bolted to the engine brackets, and the lower portions, to the brackets on frame No.25 of the fuselage.

The ends of the rods attached to the fuselage carry eyebolts thread-connected to the rods, which makes it possible to adjust the rod length as required.

The rear attachment unit of the engine is intended to take over side and vertical loads. It is comprised of two vertically arranged chromansil rods with turnbuckles (one on each side) and one horizontally arranged rod with the turnbuckles on the left side. One end of the control rods is secured to the brackets of the engine, and the other to the brackets on frame No.28 of the fuselage.

Due to the turnbuckles of the rods of the rear attachment unit the length of the control rods can be adjusted when the engine is installed on the aircraft.

To adjust the length of the control rods during aircraft operation is impermissible.

The engine is mounted on the aircraft with the fuselage tail section disjointed. The mounting of the engine requires the use of a special cart. To facilitate the mounting procedure, the compressor casing is fitted with brackets having steel rollers, and the fuselage portion between frames Nos 22 and 28, with the riveted guiding rails. The engine placed on the cart is moved on the rollers into the rails and slid as the stop on the cart permits, after which the attachment units of the engine are assembled.

Attachment of the Afterburner

The front portion of the afterburner is secured to the engine with the aid [of a] telescopic joint (See Fig.33).

The rear portion of the afterburner is attached to the fuselage with the aid [of] longitudinal guiding rails installed on the afterburner and bearing against [sp]ecial rollers. The rollers are fitted on and secured to the bushings screwed [in]to the sockets in the left and right halves of frame No.36.

The roller set in the left half is provided with beads holding the after[bu]rner against sideward travel; however, the roller set in the right half has no [be]ads, due to which fact the afterburner is free to travel to the right.

Thus, the afterburner can travel lengthwise and crosswise in response to [he]ating.

Prior to mounting the afterburner on the aircraft, the jet nozzle flap actuat[in]g ring with hydraulic cylinders should be detached. This is necessary to allow [jo]inting of the tail section of the fuselage. After joining of the tail section [t]o the fuselage, the nozzle flap actuating ring with the hydraulic cylinders [s]hould be installed on the afterburner from the side of the rear edge of the fuse[l]age and secured to the afterburner with the aid of six control rods.

2. Air Intake Duct

The air is delivered to the engine through the air intake duct (Fig.32). [W]hile in flight, part of the air is taken from the air intake duct and routed [th]rough special ports in the air cooler for cooling the engine compartment.

The air intake duct is made up of a circular air intake with a movable cone [i]n the fuselage nose section, two ducts running along the fuselage board sides, [wh]ich form one duct behind the pilot's cockpit next to frame No.16. The air cooler [o]f the cockpit air conditioning system is a portion of the duct.

The rear flange of the air cooler is fitted with a special rubber shape to [w]hich the flange of the engine compressor is tightly pressed to ensure a sealed joint.

The purpose of the airtight joint and its design are described in detail in Section "Cooling of Engine Compartment".

Movable Cone

The movable cone located in the air intake in the fuselage nose cone is meant for reducing power losses of the air flow (Fig.32).

The cone is actuated by the cone automatic control system, depending on the conditions of flight and engine operation.

Movable Cone Automatic Control

(Fig.34)

The cone extension and retraction follow-up system УВД-2М is designated to ensure stable operation of the air intake and engine in all attitudes of aircraft flight. The system operates in two duties: automatic and manual.

In the automatic duty the УВД-2М system operates on the principle that to a definite position of the cone there corresponds a certain degree of compression of the compressor Пк, i.e. to the pressure ratio $\frac{P_2}{P_1}$, where:

25X1

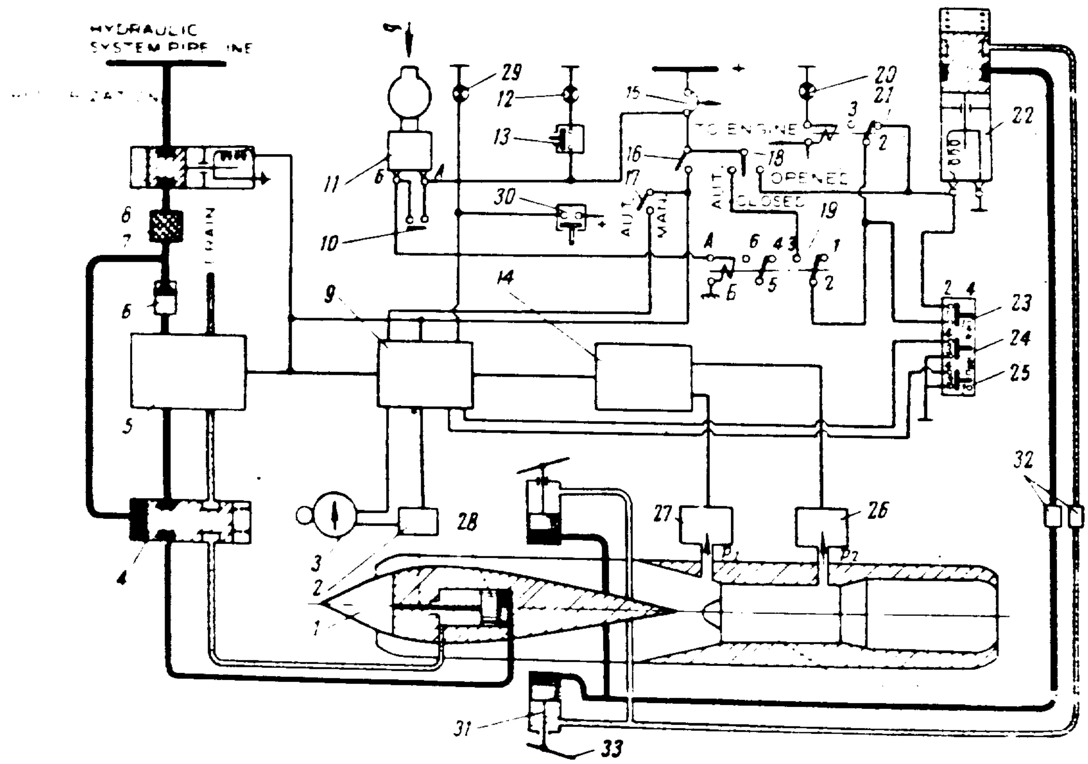

FIG.34. BLOCK DIAGRAM OF CONE AND ANTI-SURGE SHUTTERS FOLLOW-UP SYSTEM

1 – movable cone, 2 – feedback pick-up ДК-3, 3 – cone position indicator УПДС-3, 4 – hydrolock, 5 – hydraulic unit АЗ-77-1, 6 – non-return valve, 7 – filter; 8 – hydroelectric valve ГА-184У, 9 – amplification and commutation unit БУК-2А, 10 – button 204К for simulating operation of M = 1.35 number pick-up, 11 – pick-up of number M = 1.35 with filter, 12 – lamp CONE EXTENDED on light panel Т-4, 13 – limit switch КВ-9А, 14 – output signal unit [illegible], 15 – circuit-breaker АЗС-5, 16 – switch 87К, 17 – switch 87К, 18 – ППН-45 change-over switch, 19 – relay ТКЕ-52 [illegible], 20 – signal lamp AFTERBURNING, 21 – relay ТКЕ-2ПЦ for blocking anti-surge shutters at augmentation, 22 – hydroelectric valve ГА-194У, 23 – limit microswitch КВ-9А, 24 – microswitch КВМ-04; 25 – microswitch КВМ-04, 26 – pick-up [illegible], 27 – pick-up [illegible], 28 – cone control cylinder, 29 – take-off – landing unit [illegible], 30 – L.G. right strut up-position limit switch ВК-2-200Р, 31 – anti-surge shutters control cylinder, 32 – throttle, 33 – anti-surge shutters.

25X1

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P_2 is absolute static pressure behind the compressor and

P_1 is absolute static pressure before the compressor.

The cone automatic control system is interlocked by a limit switch (30) when the L.G. is retracted.

The full cone travel of 200 mm is effected by the control system at Пк changed within 4.5 - 11.5.

The maximum compression value of the compressor Пк corresponds to a completely retracted position of the cone, while the minimum compression value, to the completely extended cone position.

At Пк > 11.5 the cone does not change its position and is in position Пк = 11 (the cone is extended by 15 mm), if the L.G. limit switch is closed.

The block diagram of the УВД-2М system and the anti-surge shutter control system is presented in Fig.34.

The УВД-2М system comprises the following basic units:

(a) pick-ups ИДО-Д$_1$ (27) and ИДО-Д$_2$ (26);

(b) output signal unit ИДО-БВС-1 (14);

(c) amplification and commutation unit БУК-2А (9);

(d) hydraulic unit АУ-35-1 (5);

(e) hydroelectric valve ГА-184У (8) and hydrolock (4);

(f) limit switch (30);

(g) feedback pick-up ДК-3 with drive П-1 (2);

(h) cone position indicator УПЗС-3 (3).

The cone position automatic control system is switched on by means of switch CONE CONTROL (УПРАВЛЕНИЕ КОНУСОМ) (16).

Pressure pick-ups ИДО-Д$_1$ and ИДО-Д$_2$ are the sensitive elements of the system: they take up static pressure values before and behind the compressor, i.e. P_1 and P_2, and convert them into electric signals whose values are proportionate to the pressure values P_1 and P_2 taken up.

The voltages produced by pick-ups 26 and 27 are compared and amplified in output signal unit ИДО-БВС-1 (14) and are sent to the amplification and commutation unit БУК-2А (9) as electric signals proportionate to the ratio $\frac{P_2}{P_1}$.

The signal from unit ИДО-БВС-1 amplified in unit БУК-2А is supplied to hydraulic control unit АУ-35-1 (5).

Control unit АУ-35-1 converts the electric signals sent from the amplification and commutation unit БУК-2А into hydraulic pressure - operating fuel consumption. The hydraulic mixture pressure is supplied from the hydraulic system to unit АУ-35-1 through non-return valve 6, filter 7, hydroelectric valve ГА-184У (8) (See Chapter "Hydraulic System").

The hydraulic pressure controlling the distribution slide valve of unit АУ-35-1 shifts the slide valve thereby connecting one cavity of hydraulic cylinder 28 to the pressure line and ensuring drainage from the second cavity.

The rod of hydraulic cylinder 28 acts upon the frame of the cone moving section (See Chapter II of this Description, Section "Arrangement of Movable Cone"), and extends or retracts cone 1.

The rod of hydraulic cylinder 28 is mechanically coupled with the axle of feedback pick-up 2 by means of a cable and special drive П-1. Drive П-1 converts the forward motion of the rod of hydraulic cylinder 28 into the rotary motion of the rotor of feedback pick-up 2 (in the diagram the mechanical coupling between the hydraulic cylinder rod and the feedback pick-up is shown in a dotted line).

The turning axle of feedback pick-up 2 shifts the current-carrying brushes (sliders) of the feedback and indication potentiometers. From the indication potentiometer the signal is fed to the warning system of cone position indicator УПЗС-3.

Each position of the slider of the feedback pick-up indication potentiometer corresponds to a certain setting of cone position indicator pointer 3.

The potentiometer of feedback pick-up 2 reduces mismatching between the given position of the cone and the position that the cone must take in accordance with the induction pick-up signal.

As soon as the mismatchment signal is reduced beyond the non-sensitive limits (balancing condition), the cone actuating system stops its operation and the cone takes up a required position.

Cone position indicator УПЗС-3 is installed on the left-hand upper electric board of the instrument panel and has a graduated scale from 0 to 100% with 5% division value. The zero position of the indicator pointer corresponds to the retracted position of the cone, while 100% - to the completely extended cone position.

Beside indicator 3, there is signal lamp 12 inscribed CONE EXTENDED (КОНУС ВЫПУЩЕН) on light panel 4 in the pilot's cockpit which lights up when the cone is extended by 3-6 mm.

In curvilinear flight when the speed airflow streams at an angle to the axes of the cone and the air intake, the УВД-2М system ensures correction for additional cone extension; for this purpose the system is interlocked at stabilizer deflection angles.

For the above-mentioned purposes the superstructure in front of frame No.34 mounts pick-up ДСУ-2 with three microswitches 23, 24 and 25.

The ДСУ-2 shaped control rod is rigidly connected with the stabilizer control bell-cranks. In its movement the rod presses the microswitch at a certain moment. Microswitch 23 belongs to the anti-surge shutter control system, microswitches 24 and 25 controlling the additional extension of the cone.

When microswitch 24 operates, the cone extends additionally by 10 mm, microswitch 25 making the cone additionally extend by 15 mm.

If both the microswitches operate immediately one after the other, the cone extends by 25 mm from the position taken by the cone at that moment. The signals from microswitches 24 and 25 are fed to the additional magnetic amplifier windings of unit БУК-2А which controls hydraulic unit АГ-35-1.

Fig.35 presents charts of additional cone extension when the stabilizer nose shifts upward or downward and also switching tables of microswitches 24 and 25. The upper chart shows the value of additional cone extension at definite angles of deflection of the stabilizer nose as the latter moves downwards.

For example: When the stabilizer nose moves within the interval from $\alpha = 13^\circ$ to $+1^\circ$, both microswitches 24 and 25 are switched on (See the switching tables), and the additional cone extension is equal to $\Delta l = 25$ mm; in the interval from $\alpha = 0^\circ$ to $-1^\circ \pm 30'$ it is only microswitch 25 that is switched, and the additional cone extension is equal to $\Delta l = 15$ mm, and so on.

The horizontal lines in the chart thus indicate the value of additional cone extension, while the vertical lines, the value of stabilizer nose deflection; for illustration the figure presents sketches of different degrees of cone additional extension found at the bottom of the chart.

Manual Control of Cone Extension

The cone manual control is resorted to in emergency cases: when the automatic ntrol system fails and also when checking the aircraft control system on the und. In these cases switch 17 must be set in position MANUAL (РУЧНОЕ), the cone ension and retraction being effected by rotating of the rack and pinion on icator 3.

The signal of mismatch between the true cone position and the set value on icator 3 is fed to unit БУК-2А (9) and further on to unit АУ-35-1; as a result, cone will move in the required position and will stop when the error signal is uced to a value below the non-sensitive zone limits. In manual control no cortion is made for additional extension of the cone depending on the deflection les of the stabilizer.

In case the supply voltage disappears or the pressure in the hydraulic system ps, the hydrovalve ГА-184У (8) will lock the cone in the position which it ocied at the moment of voltage disappearance or pressure drop.

Operation of Electrical Units of System УВД-2М

Automatic Control

The L.G. struts retracted, the limit switch of the retracted position of the . right-hand strut 30 operates and closes its contacts, and the board mains ltage is fed to unit БУК-2А (9), switch 17 being set in position AUTOMATIC ВТОМАТ).

The electric signal of mismatch is fed from unit ИДО-БВС-1 to unit БУК-2А, om where the amplified signal is supplied to control unit АУ-35-1. Unit АУ-35-1 lows the hydraulic mixture to enter one of the cavities of hydraulic cylinder 28, nnecting the other cavity to the drain system. Hydraulic cylinder 28 shifts the ne as long as the signal is being applied. The potentiometer brushes of feedback ck-up 2 move together with the piston of the hydraulic cylinder. Each position the brush of the indication potentiometer of pick-up 2 corresponds to a definite sition of the pointer of indicator 3.

Note: Operation of the electrical units to effect additional extension of the cone depending on the angle of stabilizer deflection is dealt with in Section "Automatic Control of Movable Cone".

Manual Control

Manual control of the cone is effected by turning the rack and pinion of cone sition indicator УПЗС-3. The rack and pinion are coupled with the potentiometer ush of the УПЗС-3 setter and with a pointer setting the required extension of the ne.

Switch 17 is in position MANUAL. The setter potentiometer brush shifts and nds a signal to unit БУК-2А (9) after which the amplified signal is fed to control it АУ-35-1. The cone takes up the preset position. The follow-up system gets into e state of electrical quiescence.

When the cone is extended by 3-6 mm either automatically or manually, microitch 13 operates and feeds power to lamp 12 CONE EXTENDED (КОНУС ВЫПУЩЕН) which ghts up.

Automatically Controlled Anti-Surge Shutters

To obviate the appearance of surge in the air intake at high speeds of flight, tomatically controlled anti-surge shutters are installed in the forward portion of e air intake duct at frames Nos 2 and 3 on both sides of the fuselage (Fig.32).

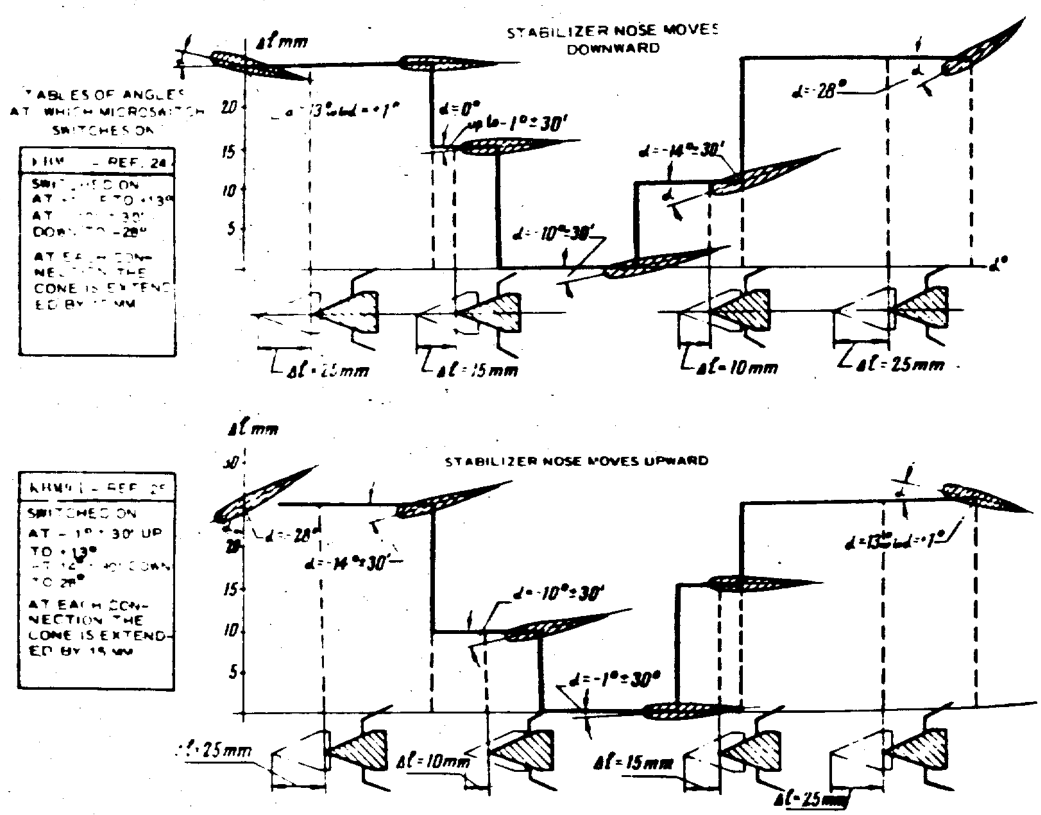

FIG. 35. CHART OF ADDITIONAL CONE EXTENSION IN CASE OF STABILIZER DEFLECTION

During flights at supersonic speeds, the air intake duct passes great mass of air. If in this case the pilot sharply pulls the engine control lever thereby increasing sharply the air consumption through the engine, then the amount of air received by the air intake will exceed the needs of the running engine. As a result, the pressure in the air intake duct will rise considerably thereby affecting the strength of the duct structure.

Besides, pressure pulsations are liable to appear in the air intake duct; these will move along the duct to aggravate the intake operation.

To preclude this phenomenon, the anti-surge shutters open as the engine r.p.m. decreases during flights performed at high speeds (M = 1.35), and the excess amount of air is blown out into the atmosphere.

The system controlling the opening and closing of the anti-surge shutters (Fig.34) includes hydraulic cylinders 31 which actuate shutters 33, hydroelectric valve 22 controlling the supply of the pressurized hydraulic fluid to the appropriate chamber of the hydraulic cylinders and at the same time joining the other chamber to the return line; the electric system which engages hydroelectric valve 22 and consists of switch 18, relay 19, switch 23 for blocking the shutter opening according to the stabilizer deflection angle, and relay 21 for blocking the opening of the shutters according to the augmented rating.

In the automatic control duty the system starts operation at speeds corresponding to M = 1.35, i.e. at the moment the voltage is being fed from terminal Б of pick-up 11 to relay 19 through whose contacts 2-3 the electric current is sent to hydroelectric valve ГА-184У (22).

In this case switch 18 is set in position AUTOMATIC (АВТОМАТ). The pressurized hydraulic fluid sets in motion the piston of hydraulic cylinder 31 which opens shutter 33.

To ensure stable operation after the aircraft has gained a speed corresponding to M = 1.35 and after the afterburner has been switched on, relay 21 is made to operate, its contacts 1-2 open, the winding of hydroelectric valve 22 is de-energized and shutters 33 close. When the augmented rating is switched off at the above-mentioned speed, the relay releases its contacts 2 - 1 and the voltage is fed to hydroelectric valve 22. As a result, the shutters open. At pitching up the inclination angle of the stabilizer is 20° (larger arm) or +2° (smaller arm), number M is equal to 1.35 and the shutters open.

In the manual control duty switch 18 is set in one of the required positions: OPEN (ОТКР.) or CLOSED (ЗАКР.). In the OPEN position of switch 18 the voltage is fed to hydroelectric valve 22 and the shutters open. In the CLOSED position the supply circuit of hydroelectric valve 22 is discontinued and the shutters close. Manual opening and closing of the shutters are carried out by the pilot irrespective of the speed of flight.

Additional Air Intake Shutters

The additional air intake shutters otherwise termed "take-off shutters" (Fig.2) are located on both sides of the fuselage at frames Nos 9-10.

These shutters are intended to decrease the degree of rarefaction in the air intake duct appearing in the engine operation on the ground and at taking off, i.e. when the ram pressure is small or nil. The shutters are secured on frame No.9 with the aid of hinges and open inside the air intake duct due to the difference in the duct and atmospheric pressures.

Through the shutters the air intake duct sucks in the outside air thereby decreasing the rarefaction in the duct and increasing the engine thrust due to increase of the air consumption through the engine.

In flight, as the ram pressure increases, the duct builds up pressures exceeding the atmospheric pressure, and the shutters close actuated by the excess pressure, at the same time somewhat decreasing the aerodynamic drag.

3. Cooling of Engine Compartment

To avoid overheating of the aircraft structure and the units of the engine in flight and to ensure proper running of the engine on the ground, the engine compartment beginning from frame No.22 is blown with air (See Fig.36).

In flight, the air for blowing and cooling the engine is taken from the air intake duct through special ports 2 protected with strainers in air cooler 1. The air flows along the outer sides of the cooler and passing through plate valves 3 in the air cooler, reaches the engine.

Having entered the engine compartment, the air passes through the space between the fuselage structure and the engine and further between the aircraft structure and the afterburner for cooling; then it escapes into the atmosphere over the fuselage edge. At the same time, part of the air is taken via a 5-mm circular slit in the web of frame No.29 to cool the outer portion of the aircraft shroud structure holding the afterburner.

Additional blowing of separate units is done with the aid of ram air intake branch pipes feeding the air to:

1. Starter-generator ГСР-СТ-12000ВТ, and generator СГО-8- by the air fed from branch pipe c arranged on the starboard hatch cover between frames Nos 27 and 28.
2. Afterburner - by the air fed through branch pipes 4 at frame No.31a.
3. Jet nozzle flap actuating hydraulic cylinder - by the air fed from branch pipes 5 at frame No.36.

Two upper branch pipes are fitted above the engine axis on the port and starboard portions of the fin, and the lower double branch pipe, along both sides of the ventral fin. This branch pipe runs along the ventral fin to merge into a common channel joined to the shroud of the jet nozzle flap control lower hydraulic cylinder.

The air sent by ram air intake branch pipes 5 runs along the connection pipe to shrouds 6 of the hydraulic cylinder, cools them and passes into the atmosphere. In this case part of the air is forced through the slit in the partition between the shrouds for blowing the hydraulic system pipes and fittings arranged along the hydraulic cylinders, after which the air is delivered to stressed ring 7 for cooling the hydraulic system pipes carrying the fluid; after that it escapes into the atmosphere through the ports in ring 7.

When the engine is running on the ground, the engine compartment is cooled by the air sucked from the atmosphere due to rarefaction created in the engine compartment upon ejection of the gases. The cooling air enters the engine compartment through twelve ports, 70 mm in dia., with disc valves 9 that open owing to the excess pressure of the atmosphere and via individual branch pipes passing additional air for blowing the units. In this case plate valves 3 on the air cooler are closed, since the degree of rarefaction in the air intake duct exceeds that in the engine compartment.

To ensure proper operation of the cooling system the engine compartment is pressurized as follows:

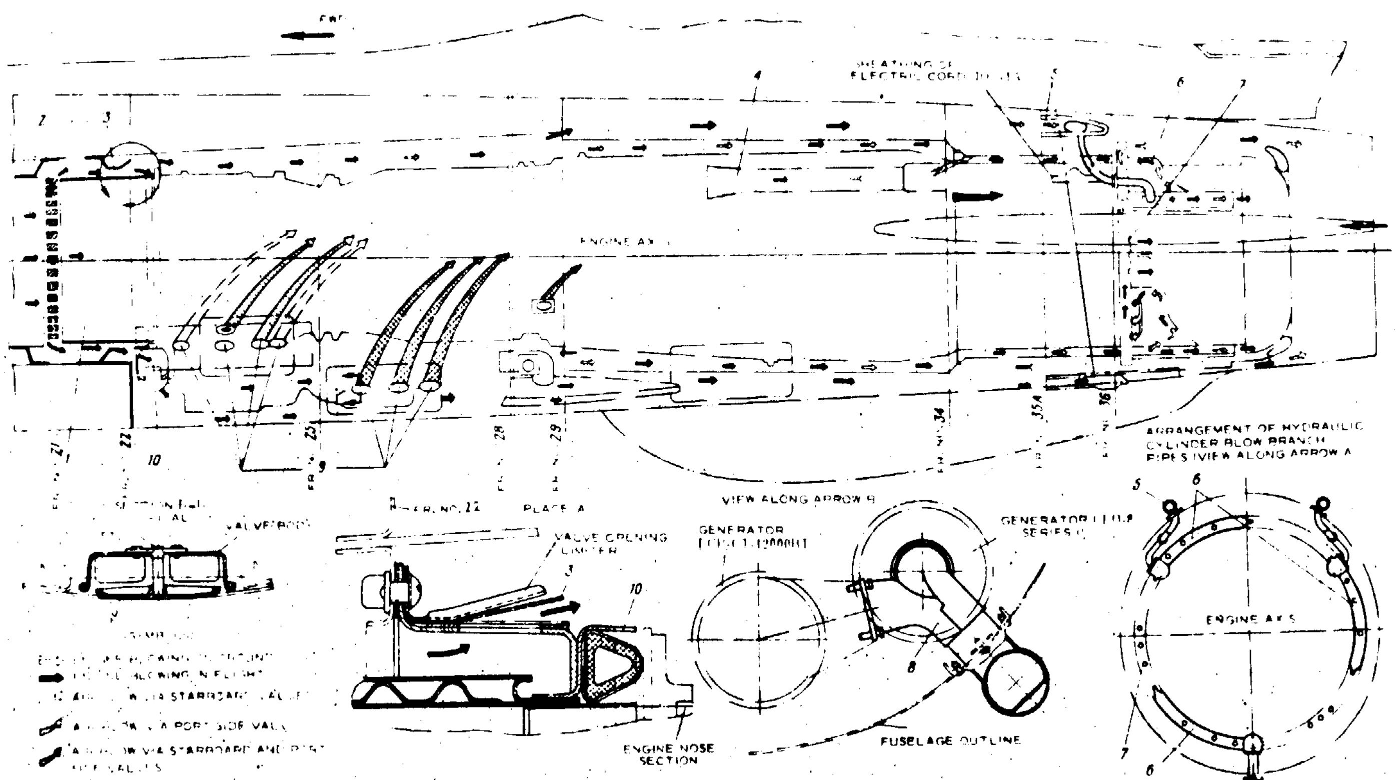

FIG. 36. ENGINE COMPARTMENT BLOWING DIAGRAM

1 – air cooler, 2 – gauze-protected ports, 3 – plate valve, 4, 5 – branch pipes, 6 – housing; 7 – stressed ring, 8 – generator blowing branch pipe, 9 – disc valves; 10 – shank

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1. At frame No.22 where the engine is joined to the air cooler with the ai of special rubber shape 10 fastened to the air cooler. The airtight integrity of joint is obtained due to compression of this shape by the flange of the engine compressor.

2. The ports passing the sections of the pipe lines in frame No.22 are clo by means of special plugs.

3. The holes leading the vent pipes of the fuel system out into the superstructure at frame No.29 and the holes in frame No.29 for passing the pipes are closed with the aid of cover plates.

4. Breathing and Drain Systems of Engine

The oil system centrifuge breathing is effected through the pipe communicating with the atmosphere through the cover of the port access door made between frames Nos 26 and 27 (Fig.37).

The pipe-to-access door joint is sealed with the aid of a rubber ring. It should be noted that leaky joint (due to deterioration of the rubber ring) may le to formation of dark carbon deposit at the joint and burning of insulation of the generator electric wiring.

Arranged at frames Nos 25 and 26 are two branch pipes for letting out the gases from the turbine shaft labyrinth sealing and from the balance chambers of the engine. The branch pipes are secured to the access doors on the port and starboar sides of the fuselage.

The vent system pipes of the engine come in groups and are led outboard at five spots.

The first outlet (when looking forward) is made at frame No.27. It connects eight vent points of the engine, i.e. afterburner valve drainage, drives of pumps HP-21$2 and HP-22$2, acceleration control unit, generator, hydraulic pumps HП34-2T and fuel booster pump.

The second outlet arranged next to the first one connects the combustion chamber drainage to the atmosphere.

The third outlet is located at frame No.32 and is used to remove the fuel fr the telescopic joint.

The fourth outlet is located behind frame No.36 and serves for draining the fuel from the fuselage skin.

The fifth outlet is made in the lower portion behind the edge of the jet nozzle. It is intended to make a connection between the vent tank installed on the engine and the atmosphere. After unsuccessful startings and after stoppage of the engine the fuel is accumulated in the tank from the fuel manifold and the valve of pump HP-21$2 to be airpressed into the atmosphere.

Apart from the above vent outlets, the fuselage skin has a number of special drainage holes (not indicated in Fig.37). Behind frame No.36 are arranged holes of 5-mm dia. located in pairs next to each stiffener of the tail cone. These holes are intended to let out fuel flowing from the afterburner when unslushing the engine on board the aircraft.

5. Service Hatches

A number of hatches are made in the fuselage skin to ensure access to the units, separate assemblies and supply systems of the engine (Fig.15, Chapter II

In the lower portion of the fuselage between frames Nos 22 and 25 and Nos 2 and 28 there are four service hatches located starboard and port side to

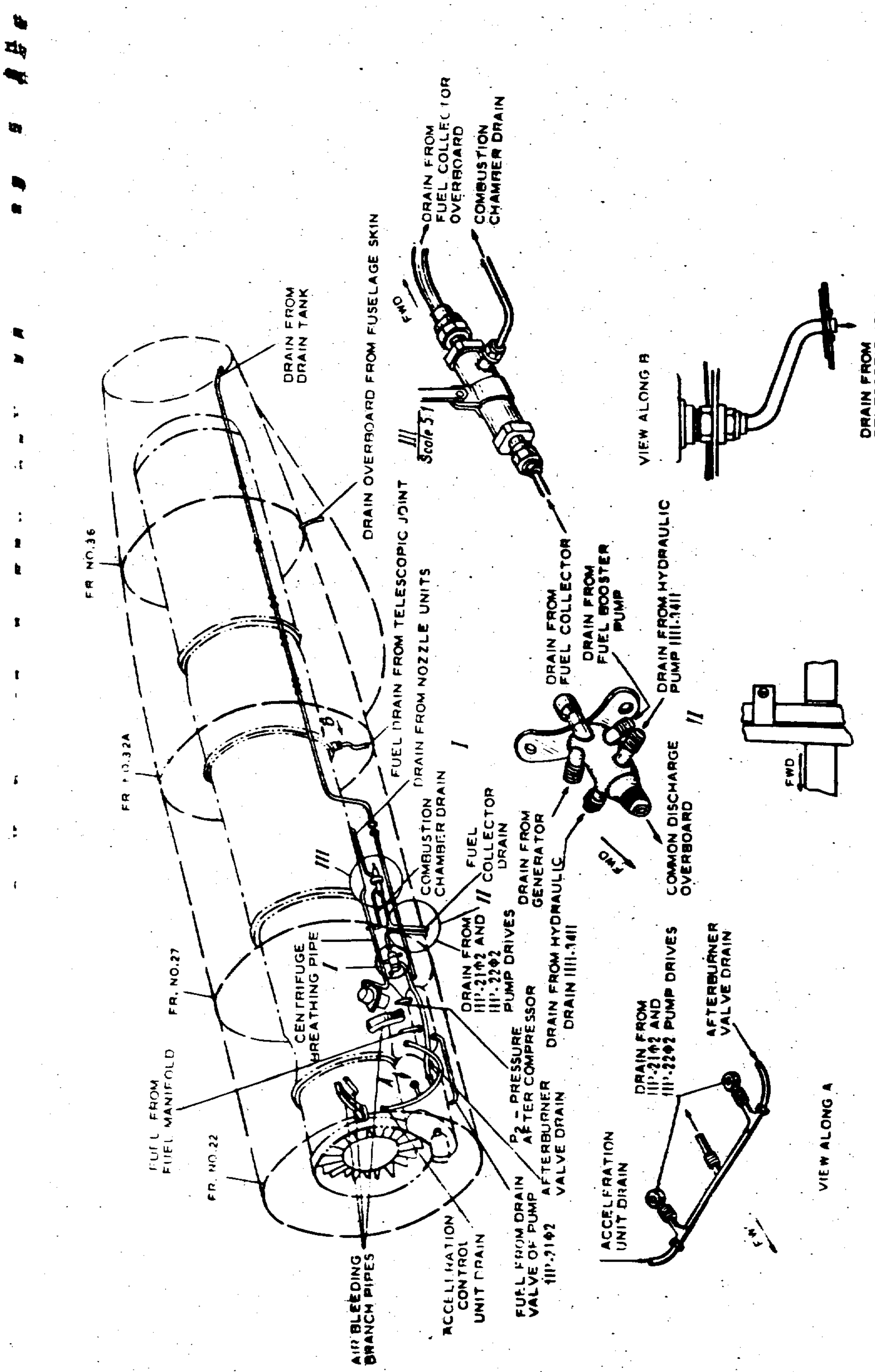

FIG. 37. POWER PLANT BREATHING AND DRAIN SYSTEMS

give access to the units and systems of the engine. These hatches are also ma use of when jointing the aircraft and removing the engine.

The hatch giving access to the fuel filler neck is arranged above on the ; dle tank at frame No.14.

The arrangement of hatches is given in the description of the fuselage st ture and the wing.

II. FUEL SYSTEM

1. Schematic Diagram and Basic Specifications

The aircraft fuel system delivers fuel to the engine at all flight altit and velocities.

The schematic and wiring diagrams of the fuel system are presented in Fig and 39.

The complete volume of fuel is accommodated in six fuselage rubberized-cl tanks (tanks Nos 1, 2, 3, 4, 5 and 6) placed in special containers formed by th fuselage structure members, four wing tank compartments (Refs 45, 48), one dro saddle-type metal tank No.7 and one metal drop tank. The construction of the v tank compartments is given in Section "Wing".

All the tanks are interconnected through tank No.7 by means of a fuel del pipeline arranged in the upper section of the fuselage (superstructure) and by fuel supply pipeline arranged in the lower section of the fuselage.

Shut-off valve 19 installed in the fuel supply pipeline serves to shut of the pipeline in emergency cases by means of electropneumatic valve 695030M an also when mounting or slushing the engine.

For venting and pressurization of the tanks, pipelines are provided which arranged in the superstructure, in closed spaces formed by frames Nos 16-22 an in the engine compartment at frames Nos 22-29.

The vent pipelines are connected with tank No.7 communicating with the at sphere through an outlet pipeline at frame No.29 through safety valves 11. The connection of the tanks with the vent pipeline and the pipelines ...gement is made so as to preclude the possibility of backward flowing of fuel from one gr of tanks into another in various evolutions of the aircraft. To prevent fuel fl ing through velocity head intake 9 in aircraft evolutions the vent pipeline be frame No.29 is made in the form of a loop.

The vent pipes of the wing tanks are connected to the common fuselage tan vent system by means of a pipeline through vent valve 6.

For venting, the drop tank uses a pipeline of its pressurization manifold.

The fuel to service tank No.3 is supplied by booster pump 495A2 (Ref. 22 · stalled in tank No.2.

From the lower portion of tank No.3 the fuel is delivered to the engine.

From the wing tank compartments and the drop tank the fuel is forced out fuselage tank No.2 by the air of the pressurization system. To provide for the sumption of fuel from the fuselage tanks and to build up normal pressure at the pump inlet (Ref. 22) when the aircraft is diving up, the fuel tanks are suppli with air from the pressurization system at an excessive pressure of 0.21 - 0.23 kg/cm^2.

The excessive pressure is ensured by means of safety valves 11 located at right side in the fuselage tail section well.

Velocity head intake 9 installed in the fuselage tail section is intended keep the required degree of pressurization in the system as the engine compress drops in response to changes in the aircraft altitude of flight.

Inset 6   Secret

Symbols
Pipeline for delivering air static pressure to unit [illegible] and for pump venting
Control pressure pipeline
Pressurization pipeline
Pipeline for delivering fuel to unit C1-3
Booster pipeline and transfer pipeline
Vent pipeline
Supply pipeline

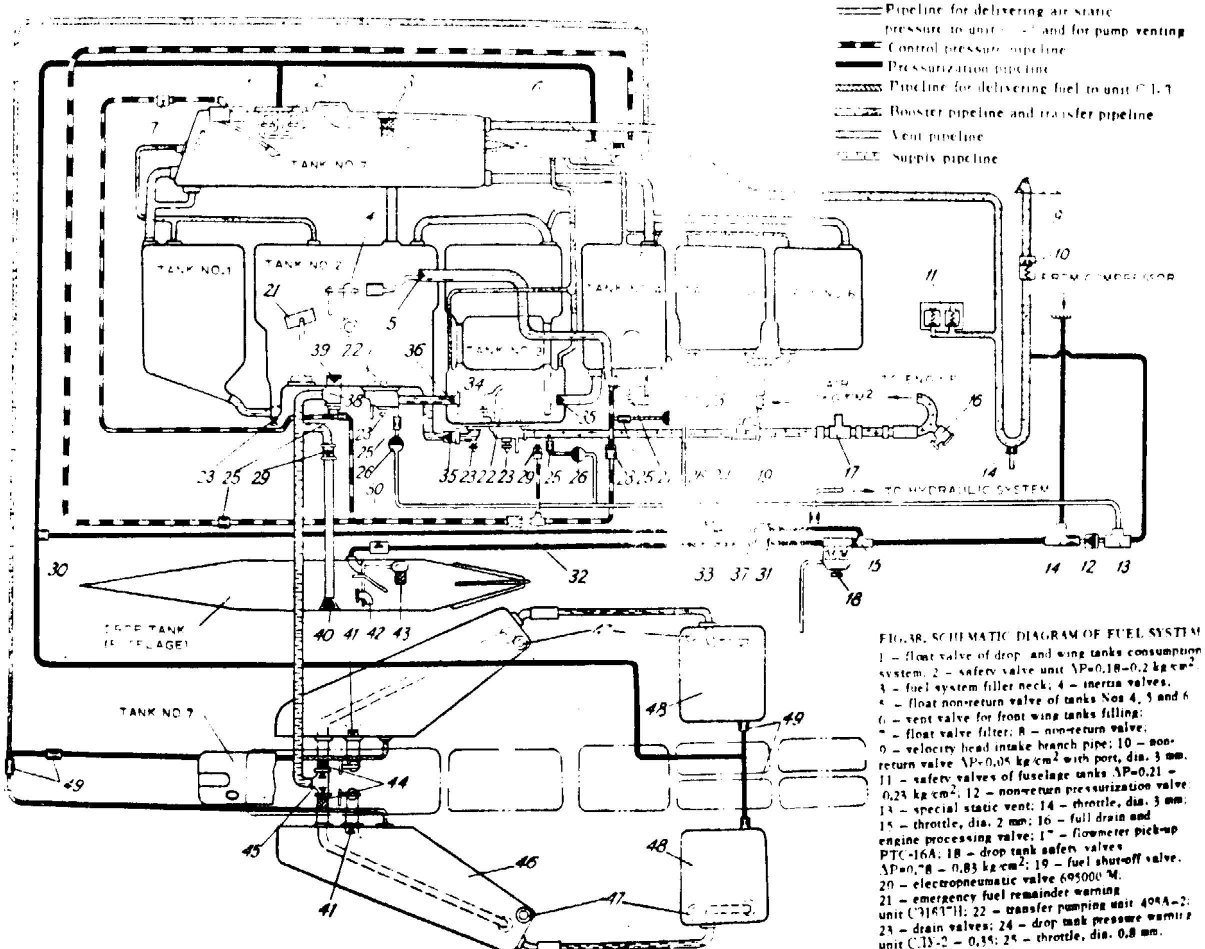

FIG.38. SCHEMATIC DIAGRAM OF FUEL SYSTEM
1 – float valve of drop and wing tanks consumption system; 2 – safety valve unit ΔP=0.18–0.2 kg/cm²; 3 – fuel system filler neck; 4 – inertia valves; 5 – float non-return valve of tanks Nos 4, 5 and 6; 6 – vent valve for front wing tanks filling; 7 – float valve filter; 8 – non-return valve; 9 – velocity head intake branch pipe; 10 – non-return valve ΔP=0.05 kg/cm² with port, dia. 3 mm; 11 – safety valves of fuselage tanks ΔP=0.21 – 0.23 kg/cm²; 12 – non-return pressurization valve; 13 – special static vent; 14 – throttle, dia. 3 mm; 15 – throttle, dia. 2 mm; 16 – full drain and engine processing valve; 17 – flowmeter pick-up PTC-16A; 18 – drop tank safety valves ΔP=0.78 – 0.83 kg/cm²; 19 – fuel shut-off valve; 20 – electropneumatic valve 695000 M; 21 – emergency fuel remainder warning unit C3161TH; 22 – transfer pumping unit 495A-2; 23 – drain valves; 24 – drop tank pressure warning unit C1J-2 – 0.35; 25 – throttle, dia. 0.8 mm; 26 – pressure warning unit [illegible]; 27 – drain pipe with funnel; 28 – non-return valve with throttle, dia. [illegible].8 mm; 29 – non-return valve; 30 – throttle, dia. 2.2 mm; 31 – non-return valve; 32 – control pressure gauze filter; 33 – throttle, dia. 1 mm; 34 – negative g valve; 35 – branch pipe with non-return valve; 36 – non-return valve; 37 – non-return valve; 38 – special valve; 39 – non-return valve; 40 – drop tank drain plug with gauze filter; 41 – non-return valve; 42 – non-return valve in drop tank; 43 – drop tank filler neck; 44 – wing tanks gauze filter; 45 – non-return valves; 46 – front wing tanks; 47 – wing tanks drain plugs; 48 – rear wing tank compartments; 49 – throttle, dia. 7 mm; 50 – vacuum valve with non-return valve.

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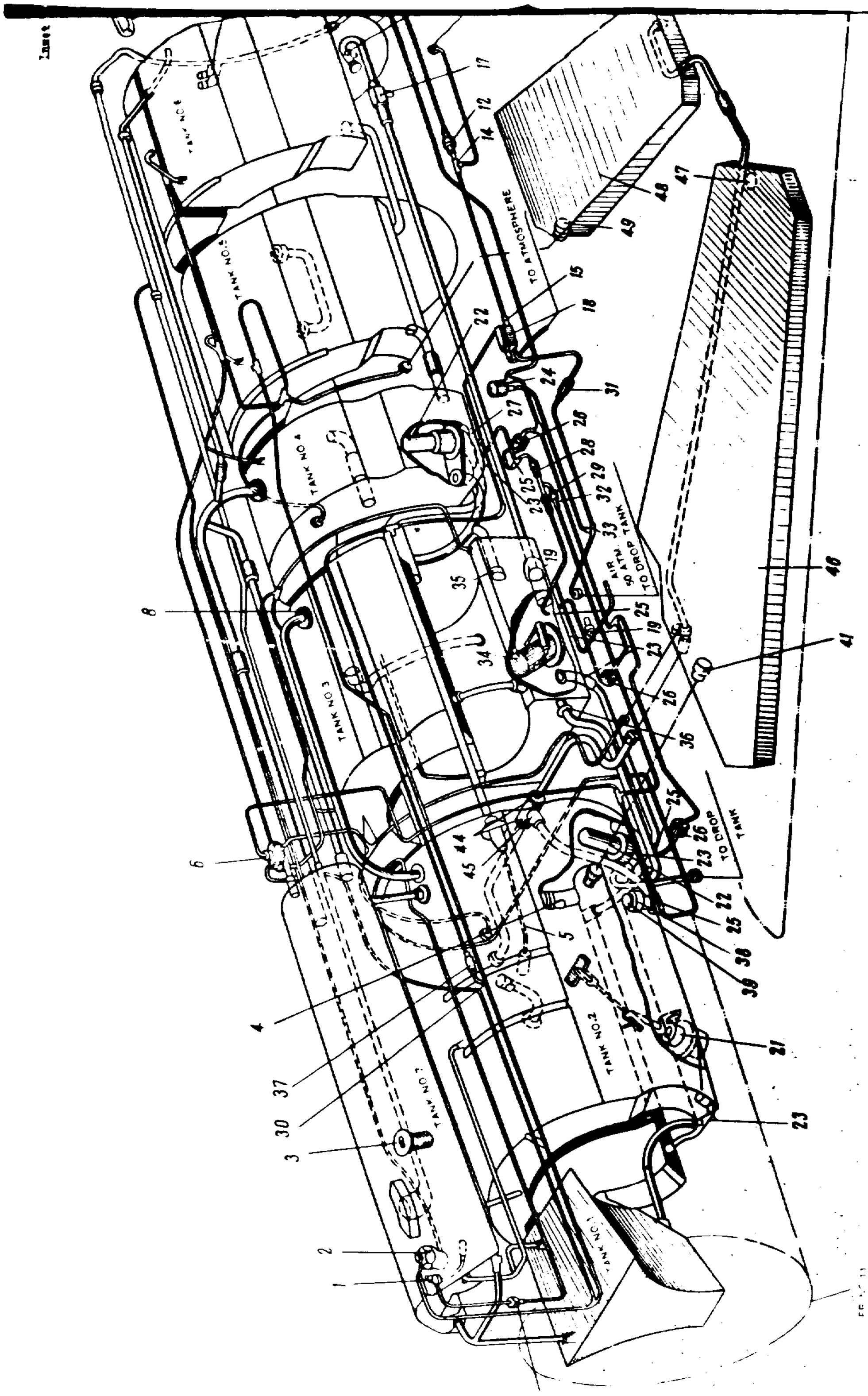

FIG. 30. PT FL SYSTEM COMPONENT PARTS

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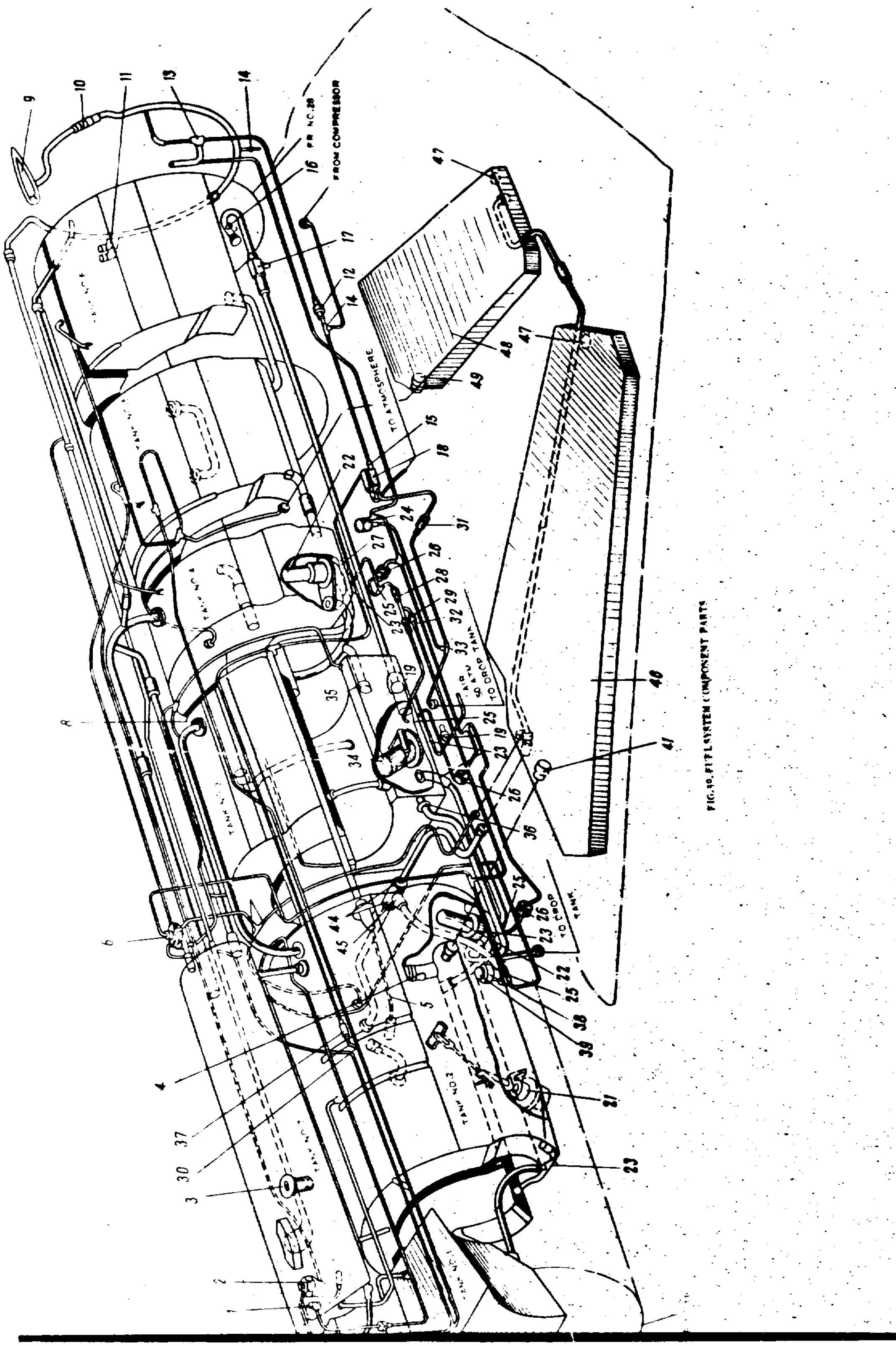

FIG. 10. FUEL SYSTEM COMPONENT PARTS

According to the sequence of consumption indicated by the respective instruments the fuel tanks are divided into the following three groups:

The first group of tanks - drop tank, tank No.7, tanks No.1 and No.2 and wing tank compartments. The second group of tanks - service group; it includes the upper and lower sections of tank No.3. The third group of tanks - tanks No.4, No.5 and No.6.

The sequence of fuel consumption is provided by special and float valves installed in tanks No.2 and No.7 (Fig.38, Refs 1, 2, 5, 6, 38).

The valves controlling the sequence of fuel consumption from the drop and wing tanks are opened and closed by the control pressure system singled out from the overall schematic diagram and presented in Fig.40. The control pressure is created by part of the fuel taken from the supply pipeline and delivered under pressure to the pipeline of the control pressure system.

To feed the engine with fuel during an inverted flight or in negative g conditions the lower portion of tank No.3 mounts negative g valve 34.

In the flights with banking inertia valves 4 installed in tank No.2 on the internal refuelling pipes, serve to prevent the fuel flow from the wing tanks into tank No.2 and backwards.

The termination of fuel consumption is checked by the outlet pressure drop of the pumps and in the drop tank. If the difference of pressure built up by the pumps and the pressure in the tanks is less than 0.3 kg/cm^2 as indicated by warning unit СД-3 and 0.35 kg/cm^2 as indicated by warning unit СДУ-2-0.35, a warning lamp lights up in the pilot's cockpit. Besides, to keep a constant check on the remainder of fuel in the fuel supply system, a hydraulic pick-up of flowmeter PTC-16A (17) with an indicator is also installed in the cockpit. Mounted in tank No.2 is C31637H float pick-up 21 sending an electric signal to the cockpit to signal the emergency fuel remainder of 520 ±50 lit.

The piping system has a number of throttle openings intended to:

1. Create increased outlet pressure of the pumps ensuring stable operation of warning unit СД-3 and the preset sequence of consumption (throttle 25).

2. Ensure stable operation of warning units СД-3 and СДУ-2-0.35 at inconsiderable pressure variations (throttles 25, 33).

3. Reduce pressure variations in the system in various operating duties of the pressure sources and of the system (throttles 33, 14, 15, 28).

4. Ensure independent operation of separate branch pipes of the piping system supplied with pressure from one source (throttle 49).

The non-return valves are intended to shift the operating medium (kerosene, air) in the required direction (valves 5, 8, 10, 12, 28, 29, 31, 36, 37, 39, 41, 42, 45) or to divide the system into sections operating independently after engine starting (valves 42, 31, 8, 39, 12).

Sediment, condensate and unused fuel are let out through drain spots (Refs 47, 40, 23, 16).

Basic Specifications of Fuel System

1. Fuel	kerosene: T-1, State Standard ГОСТ 4138-49; TC-1, State Standard ГОСТ 7149-54; T-2, State Standard ГОСТ 3410-57
2. Fuel pressure in control pressure system	corresponds to outlet pressure of pumps 495A2

3. Excessive fuel pressure in fuselage tanks relative to atmospheric pressure ... $\Delta P_1 = 0.21 - 0.23$ kg/cm^2
4. Excessive fuel pressure in wing tanks relative to that in fuselage tanks .... $\Delta P_2 = 0.12 - 0.2$ kg/cm^2
5. Excessive fuel pressure in drop tank relative to atmospheric pressure .... $\Delta P_3 = 0.78 - 0.83$ kg/cm^2
6. Filling rate .... $\leq$ 260 lit/min.

Fuel Consumption Sequence

The sequence of fuel consumption from the tanks (Fig.41) at level flight is as follows.

After switching all the pumps and starting the engine the fuel is delivered to the engine from the lower portion of tank No.3. Tank No.3 is first filled from the 1st group of tanks in the order described below. Under the action of control pressure, vent valve 6 is closed which leads to shutting off of the tank vent pipeline and to an increase of pressure in the wing tank pressurization pipeline.

(a) Fuel Consumption from Drop Tank

To ensure the required sequence of fuel consumption from the drop tank, tank No.2 of the supply pipeline mounts special valve 3a controlled (opened) by float valve 1 mounted on tank No.7. At a certain level of fuel consumption from tank No.7 the non-return ball valve of connection 26 of valve 1 closes and the control pressure increases to a value at which special valve 33 opens.

From this moment the drop tank starts delivering the fuel to tank No.2. The fuel consumption from the drop tank over, the pressurization air is released into tank No.2 via special valve 3a; as a result, the pressure in the drop tank drops and fuel consumption warning unit СДУ2-0.35 (24) of the drop tank operates.

(b) Fuel Consumption from Wing Tank Compartments

At further decrease of fuel level in tank No.7 (special valve 33 is open) the fuel from the wing tanks is delivered to tank No.2 from where it is transferred to the lower portion of tank No.3 with the aid of pump 495A2.

The fuel consumption from the wing tanks over, the pump of tank No.2 transfers the fuel from tanks No.1, No.2 and No.7 till the float valve in tank No.2 opens.

(c) Fuel Consumption from 3rd Group of Tanks

The fuel consumption from the 3rd group of tanks starts at a certain level of fuel in the upper portion of tank No.2. For this purpose tank No.2 mounts float valve 5 which will open at a certain decrease of fuel level to allow the fuel to be transferred from tanks No.4, No.5 and No.6 into tank No.2 by means of pump 22 till they are empty

The fuel consumption over, the outlet pressure of pump 495A2 of tank No.4 drops, warning unit СД-3 (26) will close its contacts and warning lamp 3rd GROUP of tanks will light up in the cockpit. At this moment the fuel remainder will be equal to approx. 620 lit. which will be shown by the РТС-164 indicator on the instrument panel.

(d) Fuel Consumption from 1st Group of Tanks

After the 3rd group of tanks the fuel will be consumed from tanks No.1 and No.2. The fuel level in these tanks decreases ... the float of the pick-up of emergency fuel

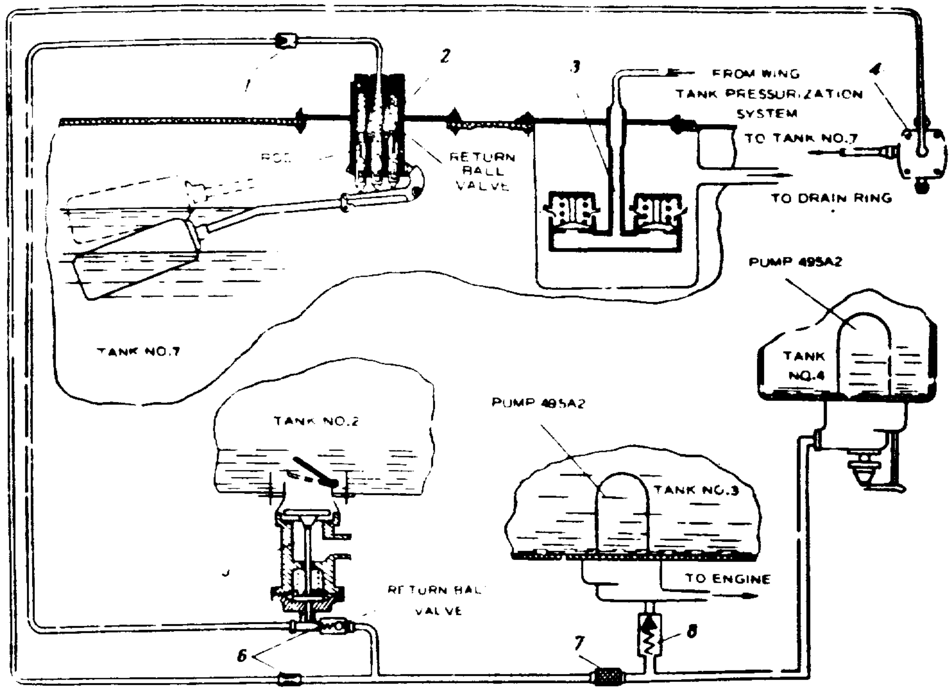

FIG. 40. DIAGRAM OF FUEL CONTROL PRESSURE SYSTEM
1 – filter, 2 – float valve, 3 – safety valve unit, 4 – vent valve for wing tanks filling, 5 – special valve, 6 – throttle, 7 – filter; 8 – non-return valve.

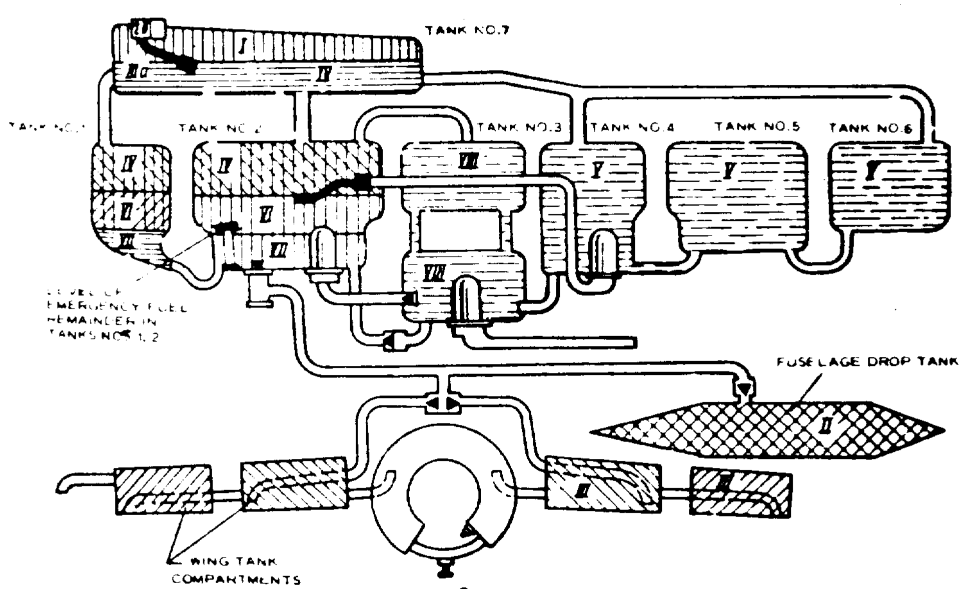

FIG. 41. DIAGRAM OF FUEL CONSUMPTION

remainder warning unit СЭ1637В (21) located in tank No.2, will go down. When the fuel level in tanks No.1 and No.2 reaches the value equal to the remainder fuel of 520 ±50 lit., the pick-up contacts will close and warning lamp EMERGENCY REMAINDER (АВ. ОСТАТОК) will light up on the light panel in the cockpit. The fuel from tanks No.1 and No.2 consumed, the outlet pressure of pump 495A2 drops and warning lamp 1st GROUP will go on in the cockpit on the light panel. This corresponds to the fuel remainder in the system of approx. 335 lit. indicated by flowmeter indicator РТС-164 in the pilot's cockpit.

(e) Fuel Consumption from 2nd Group of Tanks

Upon termination of fuel consumption from the 1st group of tanks the fuel is completely consumed from the upper and lower portions of tank No.3. The outlet pressure of pump 495A2 drops and warning lamp 2nd GROUP (II ГРУППА) goes on on the light panel in the cockpit.

The fuel consumption sequence indicated above is selected so as to bring about the least possible change in the location of the aircraft centre of gravity expressed in per cent of the mean aerodynamic chord (MAC). The centre of gravity of the fuel in the filled tanks is located approximately in the aircraft centre of gravity. At the beginning of flight depending on the flight conditions, the rear C.G. position is the most desirable from the point of view of altitude and rate of climb. The front C.G. position is the most expedient at the second part of flight when the aircraft is descending. The above sequence of fuel consumption in flight takes into consideration the above demands and brings about the least changes in the location of the aircraft centre of gravity expressed in per cent of the MAC to result in proper aircraft balancing and reliable navigation.

2. Fuel System Units

Float and Special Valves

The fuel system float valves and special valves serve for automatic fuel consumption from the tanks in the preset sequence.

The float valves are installed in the upper portion of tanks No.7 and No.2 and fastened to them by means of a plate mounting all the valve parts.

The valve installed on tank No.7 (Fig.42) consists of body 3 inserted through a port in plate 2 and fastened to the latter by means of nut 6.

The body rotation relative to the plate is prevented by means of two lugs on the body which enter the notches in the plate. Rubber ring 5 ensures airtight connection between the body and the plate.

Made in body 3 are ports which run from connections 3a, 2б and 1в. These ports accommodate springs 4 of non-return ball valves 7. Ball 7 rests against the seat in bushing 11 connected with body 3 of the float valve by means of union nut 8. Drilled in the bushing are 3 ports whose upper end faces serve as seats for non-return ball valves 7. Inserted in these ports are floating rods 10.

Fastened from outside on bushing 11 is bracket 9 which carries the axle of lever 1 with a float at the end. The float travel is limited by stops on the lever and bracket 9.

The float valve starts operating the moment the booster pumps are engaged. The float placed in kerosene is acted upon by displacement force due to which it goes up. In this case lever 1 presses in turn floating rods 10 which unseat the non-return ball valves and the control pressure in the line is released thus stop-

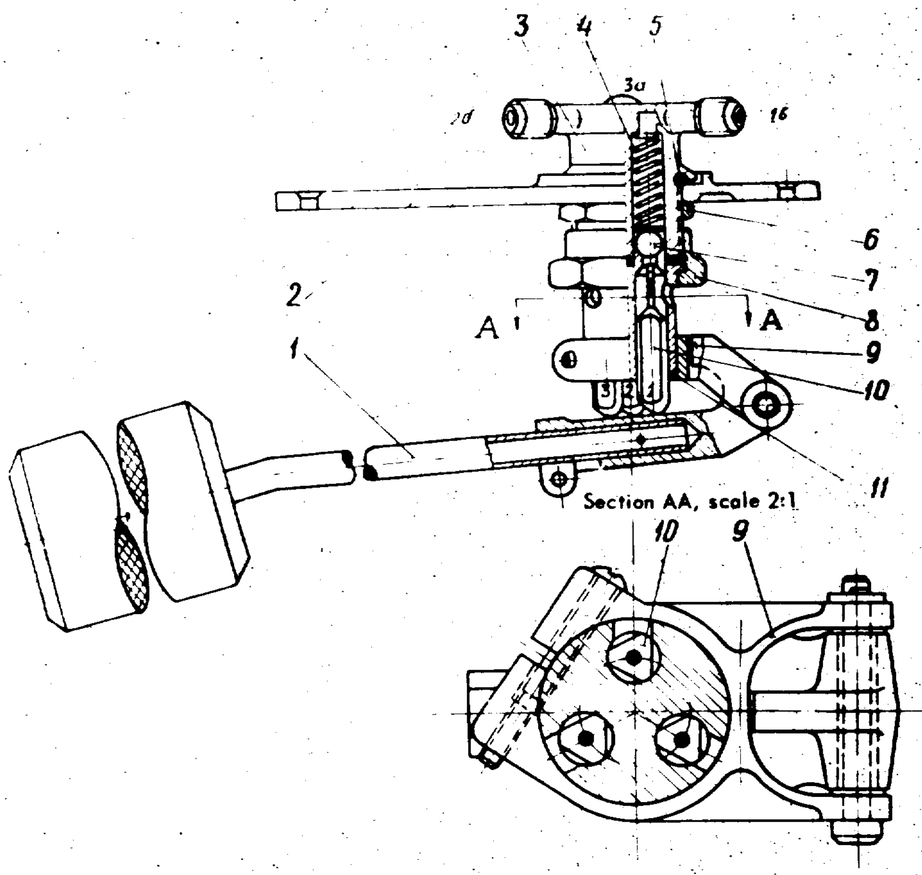

FIG.42. FLOAT VALVE
1 – float lever; 2 – plate; 3 – body; 4 – spring; 5 – rubber ring; 6 – nut; 7 – ball; 8 – union nut; 9 – bracket; 10 – floating rod; 11 – bushing

[redacted]

ping fuel transfer from the corresponding group of tanks until the fuel level in the tank with the float valve lowers.

In this case the float will go down and the lever will not interfere with rods 10 which will go down or with the non-return ball valves which will close. As soon as one of the non-return ball valves closes, the control pressure in the line connected to this valve will rise and a respective special valve will open.

As the float goes down, the non-return ball valve which is associated with connection 2б and then connection 1a, closes. As a result, release of the fuel control pressure from these lines will be stopped (connections No. 3a and 1B are not used).

The float non-return valve (Fig.43) installed in the upper portion of tank No.2 consists of body 6, non-return valve 9 and rod 2 with float 1. Body 6 with its flange is bolted to the rubber-covered plate of tank No.2. Fastened to the flange of body 6 by means of screws 10 is non-return valve 9 whose threaded connection 8 is coupled with the branch pipe of pump 495A2 on tank No.4.

The narrowing portion of body 6 terminates in a rectangular hole and a lug. Rod 2 of the float terminates in a valve riveted to the rod tube. The valve consists of fork 3 and seat 4 riveted to the fork. The sides of fork 3 are fastened to the lug of body 6 through shaft 5 which serves as a rotation axle of the rod with the float.

The float travel is limited by the support surfaces of the valve fork. The float valve starts operating the moment the fuel is transferred from tanks No.4, 5 and 6 to tank No.2 with the aid of pump 495A2. The fuel transfer is controlled by the float valve which closes as soon as tank No.2 is filled up to the required level.

The float placed in kerosene is acted upon by displacement force due to which it goes up. Rod 2 rotating about its axis closes with valve seat 4 the port in the body through which the kerosene is delivered into tank No.2. The fuel delivery in the tank is stopped.

Part of the fuel from tank No.2 consumed, the fuel level is lowered, the float with the rod goes down, thus opening the port in the valve body and giving way to the fuel flow into tank No.2. Non-return valve 9 is used to prevent back fuel flow from tank No.2 to the 3rd group of tanks.

Special Valve

The special valve (Fig.44) is installed in the booster pump line so that connection Б by means of an adapter is fastened to the tank flange and the booster pump line is attached to connection A.

Installed in special valve body 1 in the cavity communicating with the booster pump line are valve 2 and spring 3 which rest upon sliding washers 4. Diaphragm 5 is clamped between these washers and separates the cavity of the booster pump line from the cavity of fuel control pressure which is delivered through non-return ball valve 11, protective washer 8 with 0.7 mm dia. ports, throttle opening B of 0.8 mm dia. in non-return valve body 10. The latter is fastened to special valve cover 13 by clamp bolt 7 with an annular groove. The airtightness in the connection is ensured by rubber rings 6. Locking of cover 13 on body 1 is accomplished by screws 14.

When the fuel control pressure is zero, valve 2 is pressed to body 1 by spring 3 and the fuel cannot flow through the special valve. As the control pressure increases, diaphragm 5 caves in, overcomes resistance of spring 3, valve 2

[redacted]

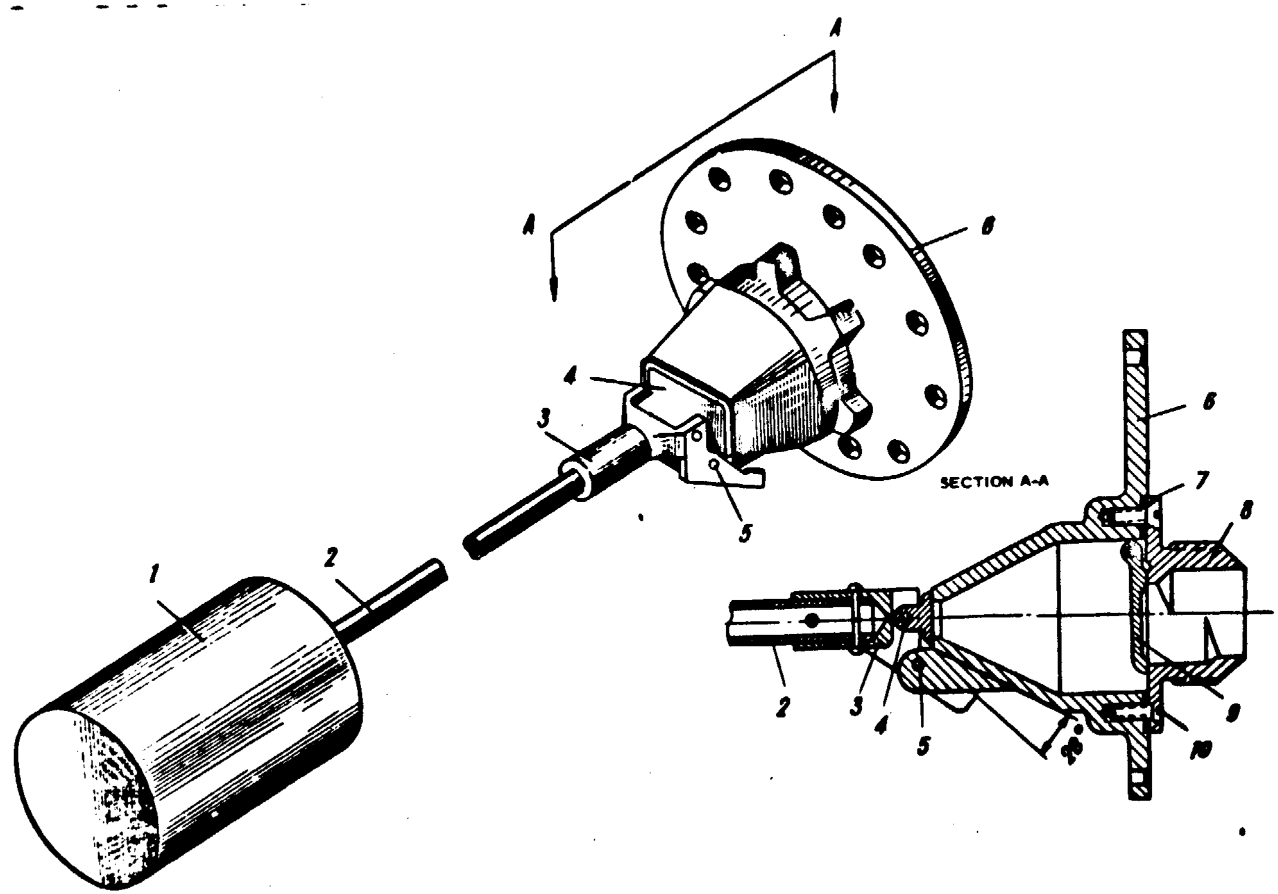

FIG.43. NON-RETURN FLOAT VALVE

1 – float; 2 – float rod; 3 – fork; 4 – valve seat; 5 – shaft; 6 – body; 7 – gasket; 8 – non-return valve connection; 9 – non-return valve; 10 – screw.

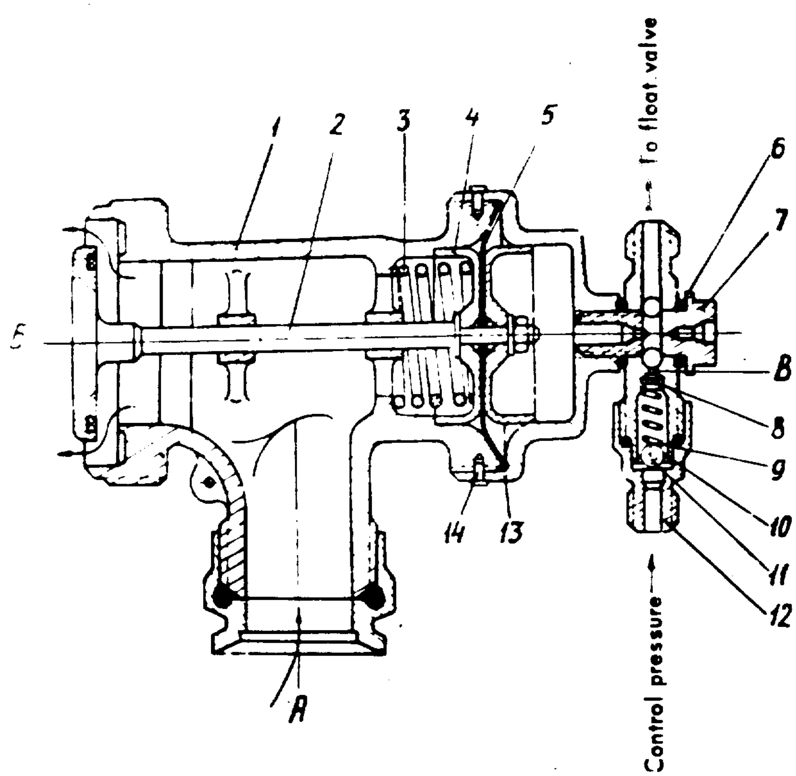

FIG.44. SPECIAL VALVE

A – from booster pump line; Б – to tank; B – throttle opening, dia. 0.8 mm;
1 – body; 2 – valve; 3 – spring; 4 – sliding protective washer;
5 – rubber diaphragm; 6 – packing; 7 – clamp; 8 – protective washer;
9 – spring; 10 – body; 11 – ball; 12 – connection; 13 – cover;
14 – screw.

travels along the guides in the direction towards the tank thus opening the way for fuel flow from the special valve to the tank, and the fuel is transferred through the special valve. The latter starts opening at a control pressure of $0.3^{+0.1}$ kg/cm^2.

Safety Valve Unit

The safety valve unit (Fig.45) is installed in the pressurization system of the wing fuel tanks. The unit is composed of the following components: body 1, safety valves proper (Refs 3, 4, 5, 6), plate 7 and connection 2. The purpose of the safety valves is to maintain the excessive pressure of $\Delta P = 0.12 - 0.2$ kg/cm^2 in the pressurization line of the wing tanks relative to the pressure in the fuselage tanks.

Vent Valve

The vent valve (Fig.46) is installed in the vent line of the front wing tanks; it consists of the following basic components: body 1, cover 2, diaphragm 3, valve proper 4 and spring 6.

The valve is intended to let out the air from the front wing tank compartments into the vent system when filling the tanks.

The moment the booster pumps are switched on, diaphragm 3 acted upon by the control pressure is caved in and shuts off the port in the body with its valve 4, the vent valve closes and shuts off the pipeline interconnecting the tanks and the vent line.

Control Pressure Filters

Installed in the control pressure line are gauze filters. The filter located at frame No.19 (called a control pressure filter) serves to purify the fuel coming to the system from the booster pump line.

The filters installed directly ahead of the float are intended to purify the fuel flowing through the float valve ducts.

Control pressure filter (Fig.47) is gauzed. Gauze 3 is soldered to frame No.4 inserted into body 5 on whose threaded portion nut 1 is screwed. The joint is sealed with rubber ring 2.

Float valve filter (Fig.48) is also gauzed. Gauze 3 is soldered to the base and inserted into body 4. The gauze base is pressed by connection 1 to body 4. Connection 1 is screwed into body 4. The joint is sealed with rubber ring 2.

Shut-Off Cock

The shut-off cock (Fig.49) is intended to close the engine fuel supply line in case of emergency and to shut it off during assembly operations.

The two-position cock is of the through type and consists of body 2, connection 1 tightly attached with the body, valve 3, lever 4, spring 5 which fixes valve 3 in position OPEN (ОТКРЫТО) or CLOSED (ЗАКРЫТО). Lever 4 coupled with valve 3 is fitted on axle 7 which is rotated by means of cock control guide 6. As the axle rotates, spring 5 gets compressed offering resistance to the guide motion. When passing the middle position, the spring changes the direction of its action: it starts acting in the direction of the valve movement and fixes the valve in the extreme position.

The end of axle 7 projecting from the cock inner cavity is sealed by two rubber rings.

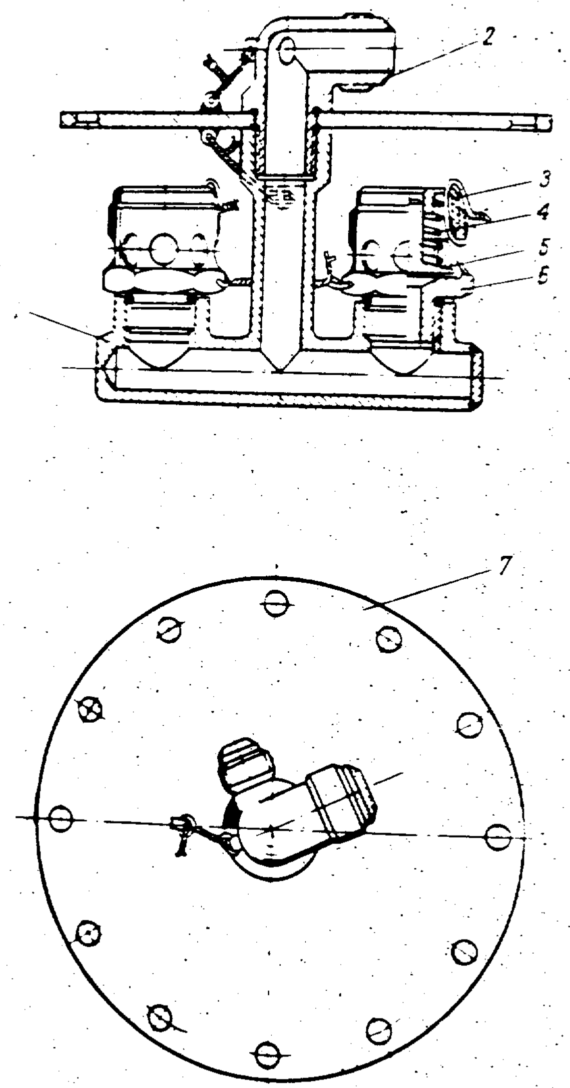

FIG.45. SAFETY VALVE UNIT
1 – body. 2 – connection. 3 – cover. 4 – spring. 5 – valve. 6 – body. 7 – plate.

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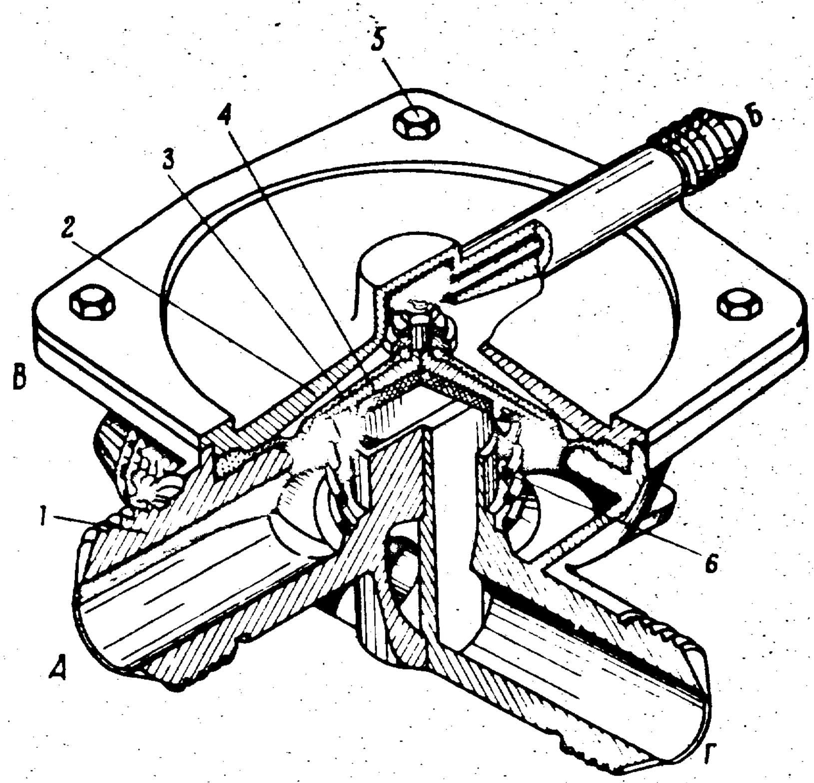

FIG.46. VENT VALVE FOR WING TANK FILLING.
1 – valve body; 2 – cover; 3 – diaphragm; 4 – valve; 5 – bolt; 6 – valve spring.

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The cock is remote-controlled from the pilot's cockpit. Installed on the left-hand console is a button labled SHUT-OFF COCK (ПОЖАРНЫЙ КРАН) closed with a protective cover.

Depressing the button for 3-4 sec. feeds power to the windings of electropneumatic valve 695000M installed near the shut-off cock at frame No.21.

The electropneumatic valve operates and transfers the air pressurized to 50 atm. gauge through the pipe into cylinder 8. Piston 9 moves out, breaks the locking wire of guide 6, shifts the latter, thus closing the shut-off cock.

Electropneumatic valve 695000M is open only when the button on the console is depressed. Therefore, for reliable closing of the shut-off cock keep the button depressed for 3-4 sec., but not more than 15 sec.

The cock should be opened only manually on the ground through the lower hatch at frames Nos 20-22. The cock open, the guide should be locked with wire.

During assembly work the cock may be opened and closed manually by means of guide 6.

Drain Valve

The drain valve (Fig.50) is installed on the pipe delivering fuel to the engine at frame No.28.

The valve is designed to drain fuel from the tanks and the fuel system and also to process the engine. The valve consists of body 4 welded to the engine fuel supply pipe. Screwed into body 4 is rod 3 with valve 5 made of teflon. Nut 1 with glued and vulcanized rubber gasket 2 is also screwed into the body to limit the rod travel.

Welded to the body is drain connection 6 covered by plug 7.

The valve opens when rod 3 is screwed out and vice versa. To fully open the valve it is necessary to screw the rod out as far as nut 1 and rubber gasket 2 permit. The gasket simultaneously serves as a packing gland of the valve rod. The rod has flats for a wrench with a 24-mm span.

The valve passage dia. is 30 mm. To drain the fuel, it is necessary to take away the plug from the drain connection by turning the plug so that the two lugs on the connection are clear off the notches in the plug, then attach the ground hose end, open the valve, engage the booster pumps of the second group of tanks and that group of tanks which has to be emptied; after that the fuel may be drained.

When processing the engine without removing it from the aircraft, it is necessary to fit the drain connection with an adapter to be found in the ground equipment set.

Safety Valves

The safety valves (Fig.51) are installed in the pressurization system of the fuselage tanks and serve to maintain in the tanks constant excessive pressure of 0.21 - 0.23 atm. gauge.

The valve consists of body 2, valve proper 3 and cover 5 screwed into the body; the cover allows tension of spring 4 to be adjusted when assembling and calibrating the valve.

The valve opens at an air pressure of 160 $\pm$4 mm of mercury.

The valves are installed in the fuselage recess at the starboard side, at frame No.29 on the pipe connected with the vent pipeline ring. From outside the valves are covered with gauzed caps which is removed during assembly or disassembly. Packing rubber gaskets 1 seal the safety valves recess from the fuselage interior.

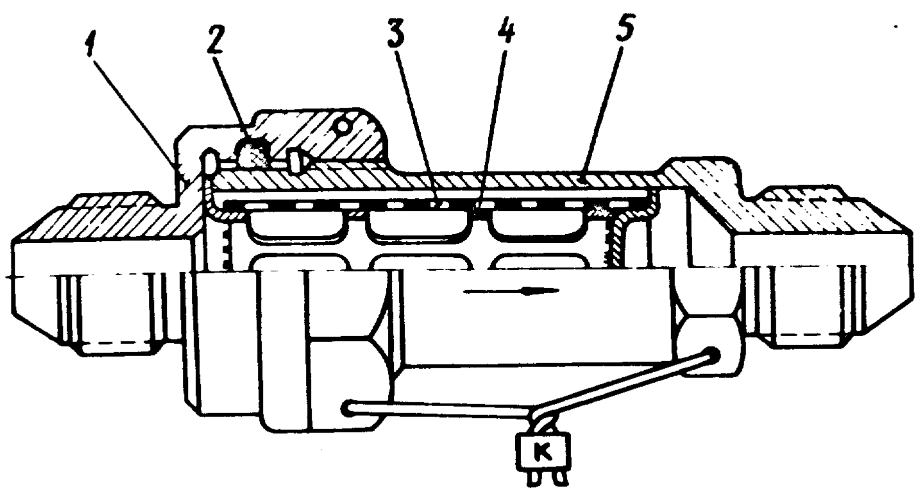


FIG.47. CONTROL PRESSURE FILTER
1 – nut; 2 – rubber ring; 3 – gauze; 4 – framework; 5 – body

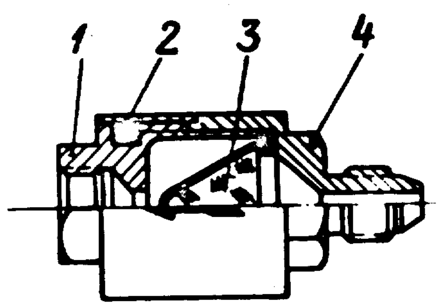


FIG.48. FLOAT VALVE FILTER
1 – connection; 2 – ring; 3 – gauze; 4 – body.

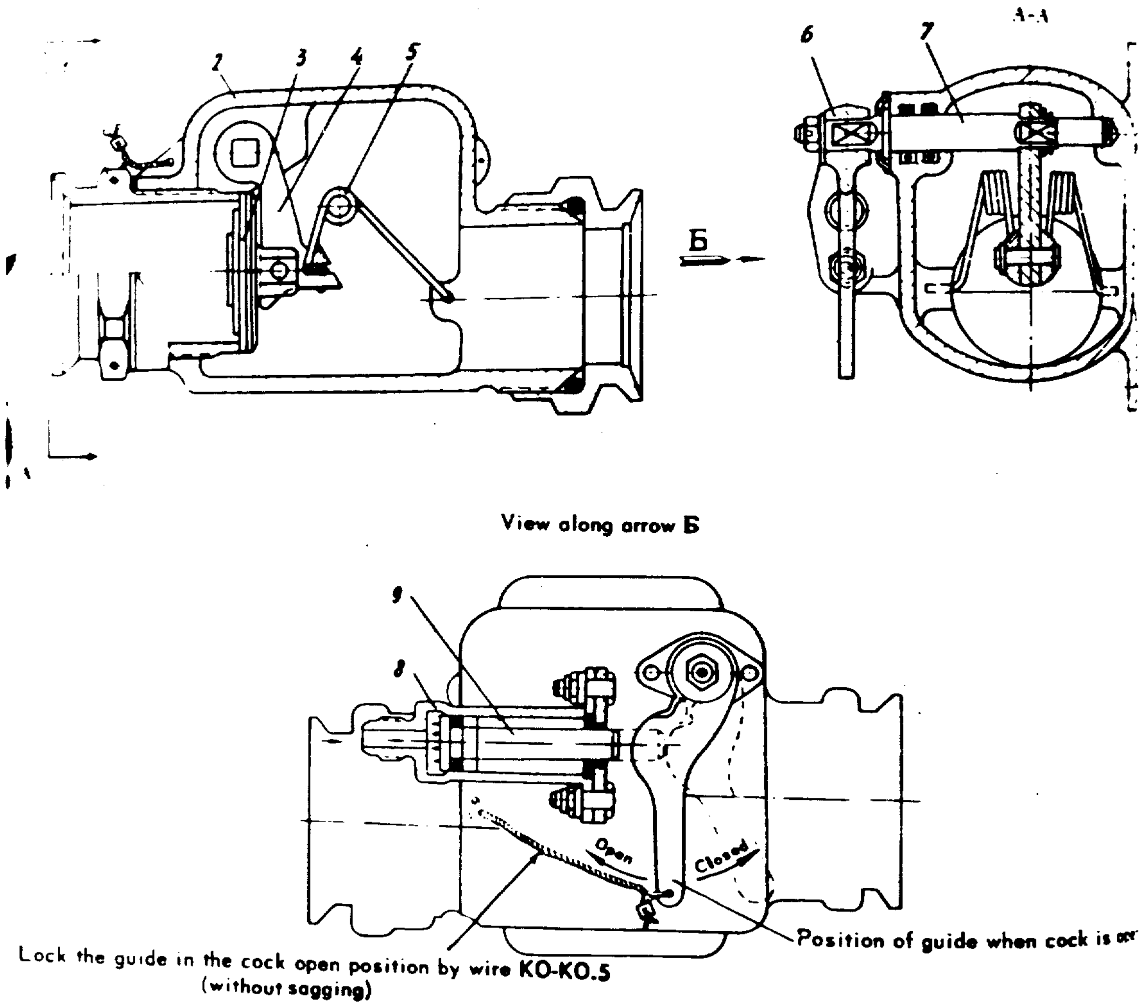
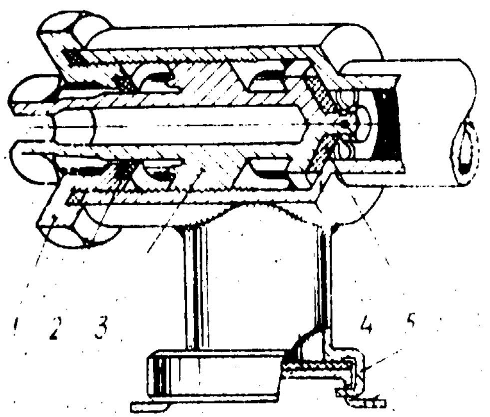


FIG.49. SHUT-OFF COCK
1 – connection; 2 – body; 3 – valve; 4 – lever; 5 – spring; 6 – guide; 7 – axle; 8 – cylinder; 9 – piston.



Operation diagram

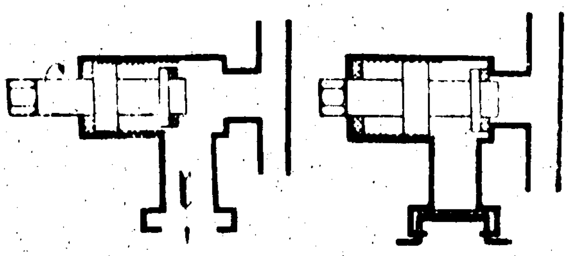


FIG.50. DRAIN VALVE
1 = nut; 2 = rubber gasket; 3 = rod; 4 = [illegible]; 5 = valve;
6 = drain connection; 7 = plug

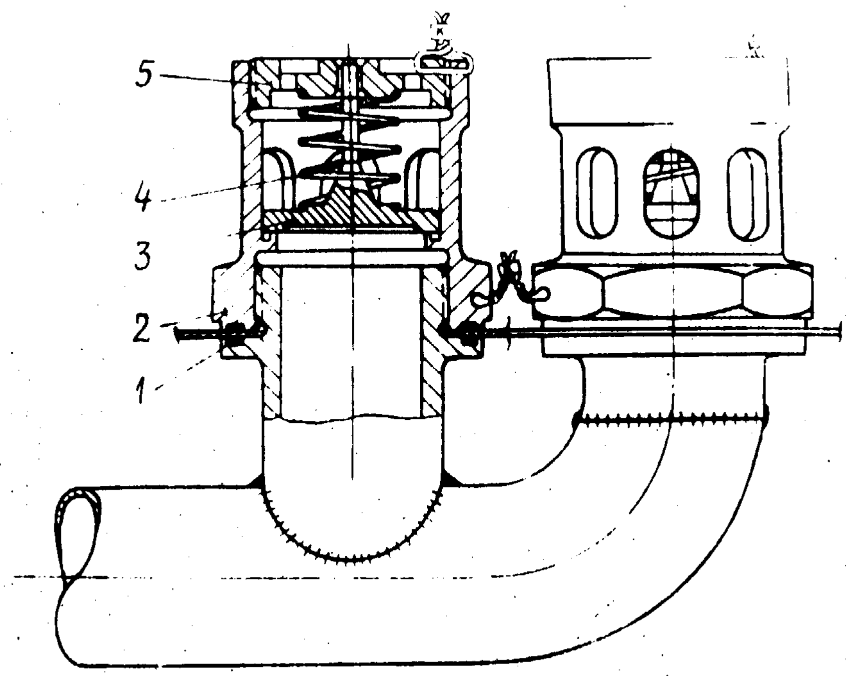


FIG.51. SAFETY VALVES
1 = gasket; 2 = body; 3 = valve; 4 = spring; 5 = cover.

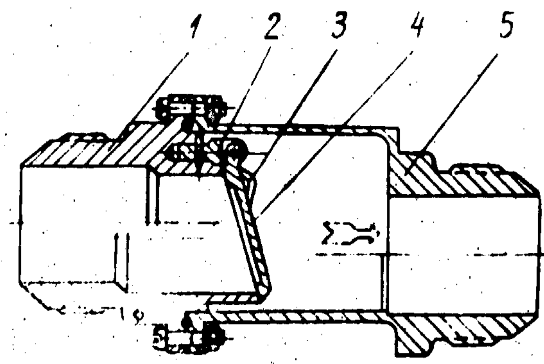


FIG.52. NON-RETURN VALVE
1 = connection; 2 = lug;
3 = spring; 4 = flap valve;
5 = body.

Non-Return Valves

All non-return valves of the fuel system, except the valves in the control pressure line, are of the flap type and close by gravity. The valve (Fig.38, Ref. 10) is installed in the vent pipeline, is spring-loaded and opens at a definite pressure differential. This valve is presented in Fig.52.

The non-return valve (Fig.52) consists of body 5 and connection 1 with flange attached by bolts.

The flange joint is sealed by a rubber gasket. Flap 4 of petal type closes under the action of its own weight and spring 3. The flap rotates on the axle inserted in lug 2 pressed into connection 1. The lug is fixed in the connection by means of a pin.

The non-return valve is made airtight by lapping the contacting surfaces of the flap and connection 1.

The valve opens at a pressure of 0.05 kg/cm^2.

Installed in the control pressure system are non-return valves of the ball or disc type (Fig.40).

Unit 495A2

Unit 495A2 is a centrifugal pump driven from an independent electric motor, type МГП-700, and installed in the fuel system for boosting and pressurizing fuel at the inlet of the engine pump, as well as for increasing operational ceiling of the fuel system. The schematic diagram of pump operation is presented in Fig.53.

Electric motor 1 is an integral part of the pump, being attached to the pump body flange. The engine is cooled by the fuel surrounding its body and also by the ambient air entering through special ducts in pump body 6; the used air flows into the atmosphere through a vent connection.

The cooling system is given in Fig.55.

The electric motor is a compound, four-pole unit designed for operation from the two-wire aircraft mains. The technical specifications of the electric motor, type МГП-700А, are as follows:

Supply voltage	27 V
Current consumed	not more than 37 A
Speed of shaft rotation	6100^{+300} r.p.m.

Unit 495A2 is fastened to the bottom of the 3rd tank in the negative g compartment and to the bottoms of the 4th and 2nd tanks. The inlet duct of the pump is always filled with fuel.

The fuel is delivered to the central portion of impeller 7. When the pump is engaged, the impeller rotates and creates translatory and rotary motion of the fuel increasing its speed and pressure. The fuel is ejected from the impeller duct along its outer diameter and flows into a volute collector and then to the boosting branch pipe duct which is a continuation of the collector.

The collector is connected through by-pass pipe 4 with the tank cavity to make unit operation more stable (the fuel pressure pulsations being damped).

Installed in the bottom portion of the collector is a drain cock to drain water condensate (not shown in Fig.53).

Fig.54 represents main performance curves of unit 495A2. It shows pressure drop P created by the pump and consumed current intensity I versus fuel consumption Q.

When the electric motor is inoperative, the fuel flows from the tank into the line both along impeller 7 and through non-return valves 5 (opened in this case) which decrease the pump hydraulic resistance.

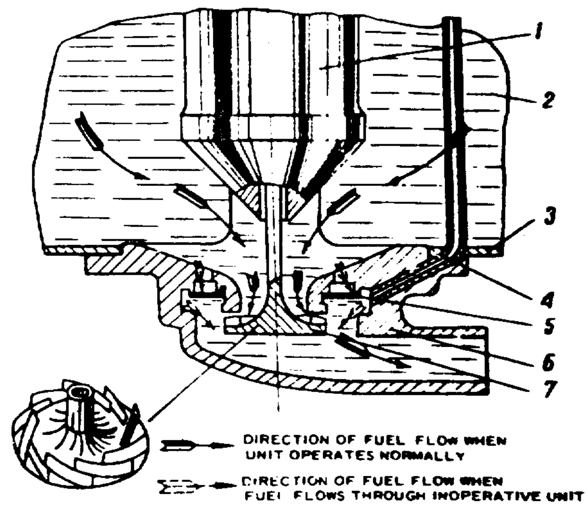


FIG.53. OPERATION DIAGRAM OF UNIT 495A2
1 – electric motor; 2 – inverted flight valve; 3 – body;
4 – by-pass pipe; 5 – non-return valves; 6 – body; 7 – impeller.

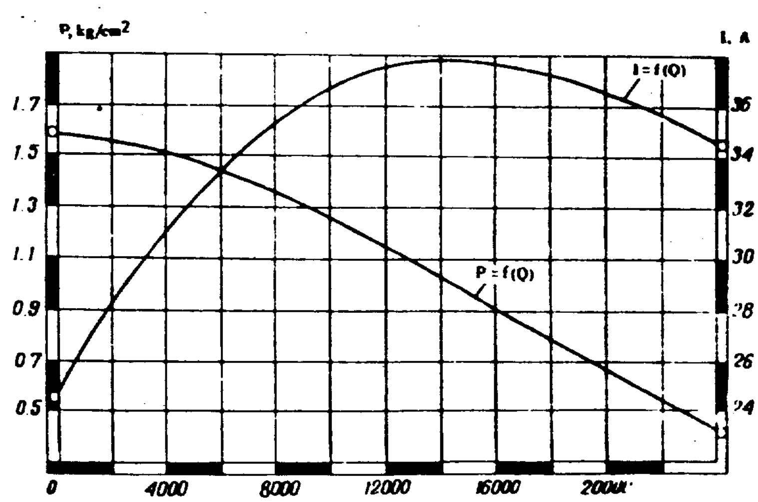


FIG.54. GRAPH SHOWING PRESSURE AND CURRENT INTENSITY VERSUS UNIT 495A-2 CAPACITY

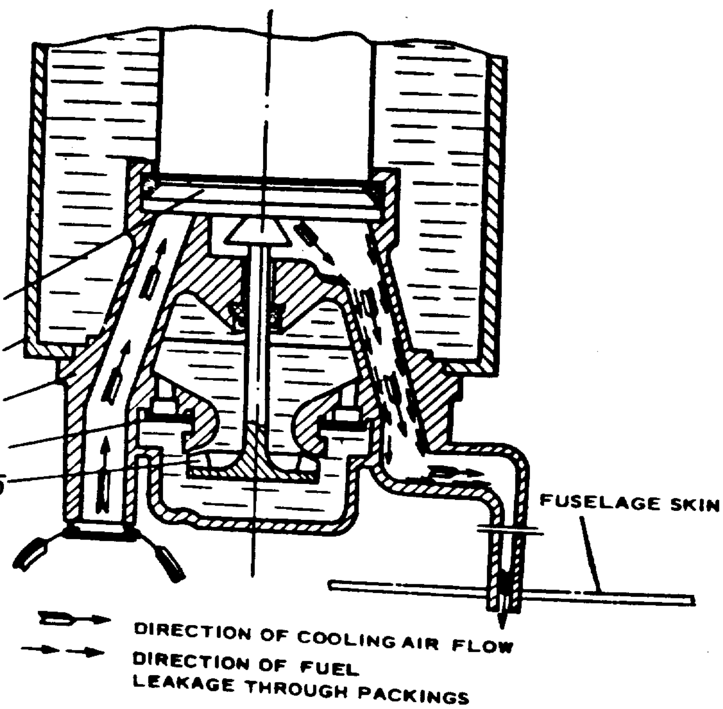


FIG.55. DIAGRAM FOR COOLING ELECTRIC MOTOR OF UNIT 495A-2
1 – electric motor; 2 – inverted flight valve; 3 – body; 4 – valve; 5 – impeller.

3. Fuel Tanks

General

All fuselage tanks are of the bag type; therefore, they are arranged in special containers to relieve the tank walls from stretching strains.

The tank walls are made up of two layers:

(a) inside layer of kerosene-resistant rubber, 0.5 mm thick;

(b) outside layer of fabric AXKP cured to place with the aid of glue.

The total thickness of the tank walls is up to 1 mm.

The joint seams of the inside rubber layer are overlapped by 25 to 30 mm.

The joint seams of the outside fabric layer are covered with tape of a lighter type of AXKP two-sided fabric cut at an angle of 45° to the warp.

The total thickness of the tank increases in places where valves and fittings are inserted and also due to an increased number of component layers.

The tanks are glued over on special split-type form-blocks.

The fittings used on the tanks are of two types: rubber-coated metal parts and all-cured, or soft parts. The rubber-coated metal parts and soft parts are glued over separately, having been partially cured and then glued to the tank with the help of separate layers of rubber interlaid by the AXKP fabric. After this the tank is subjected to an overall curing.

To take out separate sections of the form-block cuts are made in the tank, if the holes available are too small for this purpose. The cuts are then patched, for which the outer layer of the AXKP fabric is torn away at the cut to a width of 40 mm at each side of the cut. This piece of fabric is then replaced by two layers of rubber, 30 and 80 mm wide, which are glued over symmetrically. The rubber layers are finally covered with a layer of the AXKP fabric.

To avoid scores, the edges of the fabric are glued over with an approx. 20-mm wide strip of rubber. Then, depending on the size of the cut, the local or all-over curing is repeated.

Tank No.1

Tank No.1 (Fig.57) is located between frames Nos 11 and 13 between the side air intake ducts.

The tank is secured to the fuselage structure by means of pins 4. In the upper portion the tank mounts two soft connections 1 and 3 used to attach the vent pipe and fuel supply pipe from tank No.7.

In the lower portion the tank mounts connection 5 for attachment of the pipe connecting tanks No.1 and No.2.

Tank No.2

Fuselage tank No.2 is located under the air intake duct between frames Nos 13 and 16 (Fig.58).

The tank is fastened to the fuselage structure by means of pins 2.

The tank has five soft connections: one connection 4 located in the upper part and used as a tank vent, two connections 7 located in the lower part near the tank rear wall and used to mount the pipe connecting tank No.2 with tank No.3, and two connections 10 located in the lower part near the tank front wall and used to mount the pipe connecting tank No.2 with tank No.1.

The flanges with the rubber-coated metal plates of the tank are intended for the following purposes:

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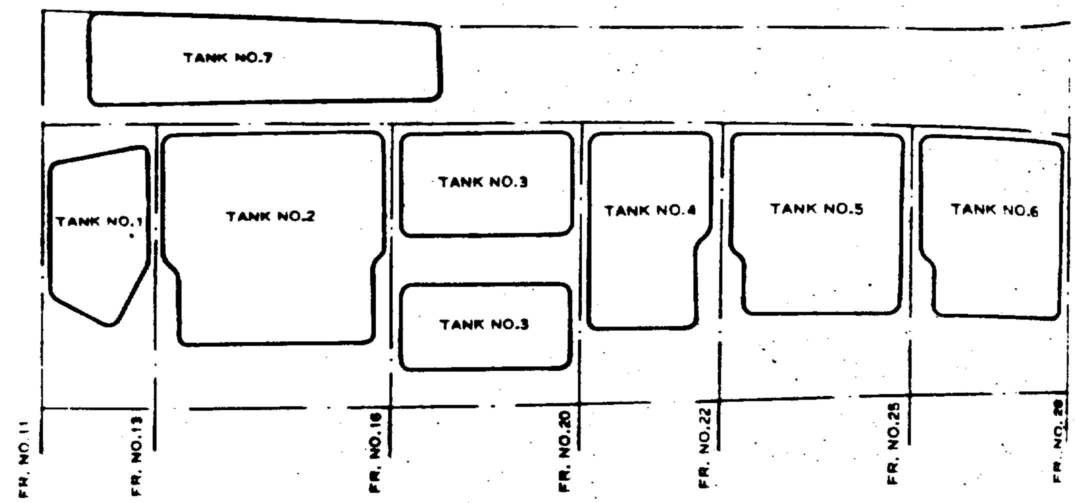

FIG.56. ARRANGEMENT OF FUEL TANKS IN FUSELAGE

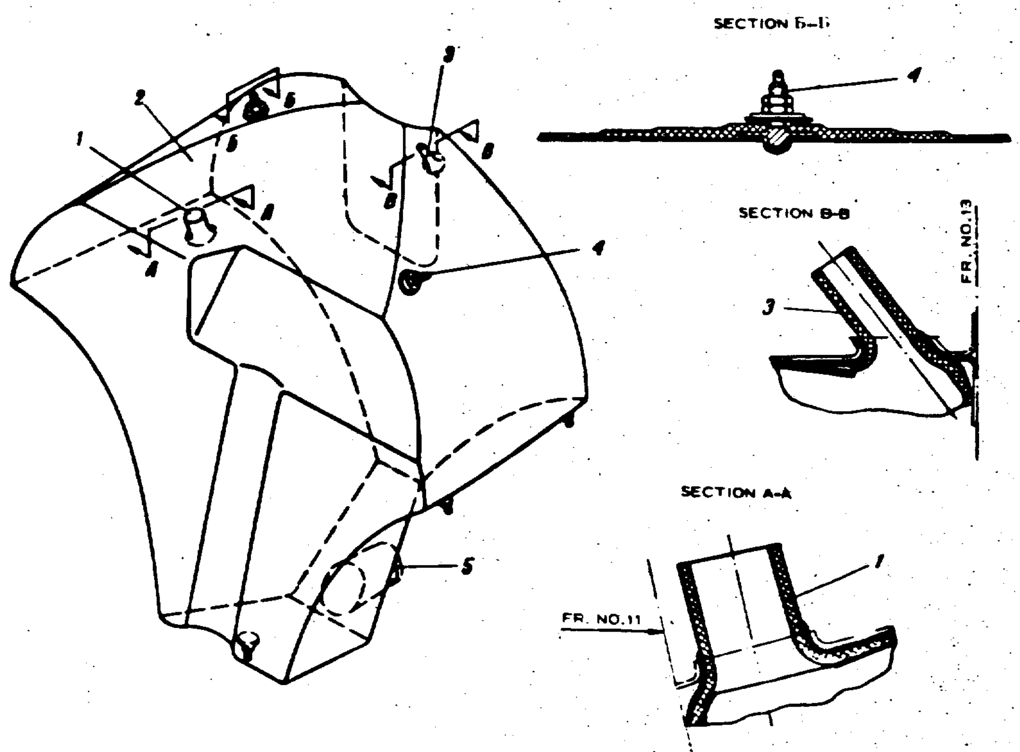

FIG.57. TANK No.1
1, 3, 5 – flexible connections; 2 – tank; 4 – pin.

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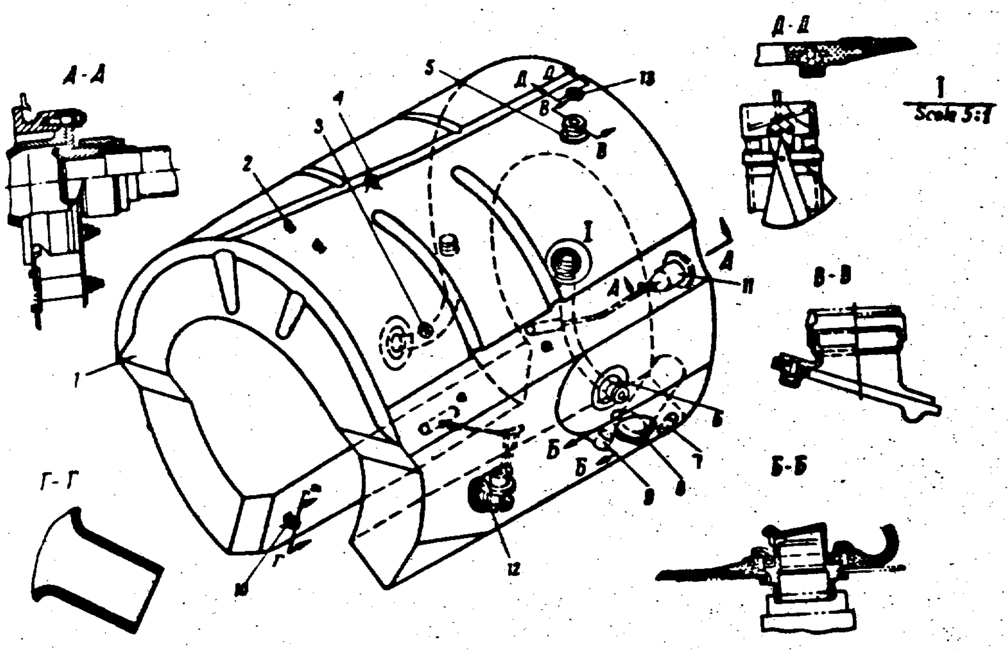

FIG.58. TANK No.2

1 – tank; 2 – pin; 3 – branch pipe with inertia valve; 4, 7, 10– soft connection; 5, 13 – soft flange; 6, 9 – flange; 8 – pump 495A-2; 11 – float valve; 12 – emergency fuel remainder warning unit float pick-up СЭ1637Н.

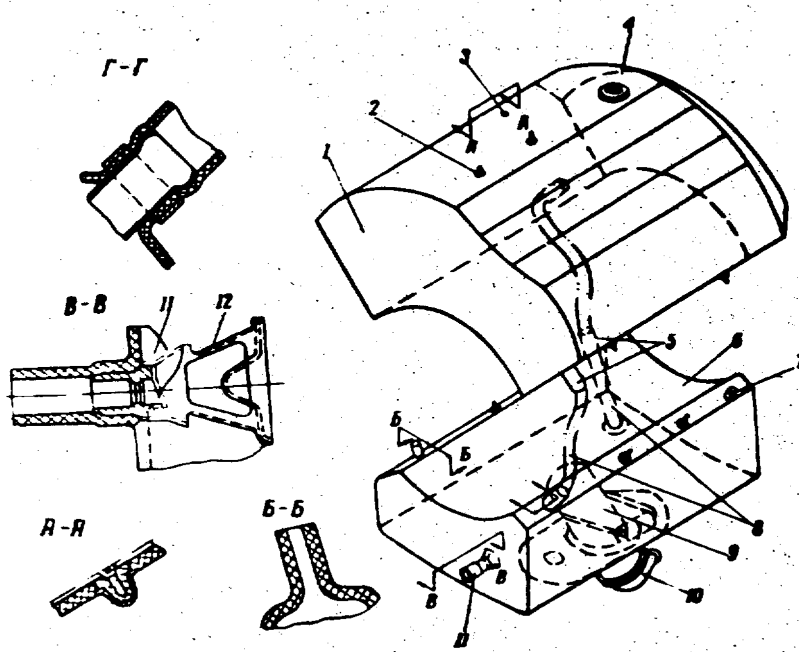

FIG.59. TANK No.3

1 – tank upper portion, 2 – pin, 3 – screw; 4 – flange, 5, 7 – soft connections; 6 – tank lower portion; 8 – connecting pipe; 9 – negative g compartment, 10 – pump 495A-2; 11 – non-return valve, 12 – baffle.

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(a) flanges 9, located in the lower part of the tank at the left side, between frames Nos 15 and 15A, are used for the attachment of the non-return valve; attached to this valve is a special valve used to transfer the fuel from the drop tank and wing tanks; the flanges located between frames Nos 15 and 16 serve to attach adapter 8 of pump 495A2;

(b) flanges 6, located at the left-hand and right-hand sides of the tank, are used for the attachment of wing tanks filling branch pipes 3 with inertia valves;

(c) flange 5, located in the upper part of the tank at the left-hand side, is used to mount the branch pipe for delivering the fuel from tank No.7;

(d) flange 13, arranged in the upper part along the tank axis, is used to mount the branch pipe of the fuel flow line connecting tank No.2 with tank No.3.

The inertia valves installed in the upper section of filling branch pipes 3 shut off these branch pipes when flying with great pitch and large side overloads.

Installed on the rear wall of the tank (See section A-A) is float valve 11. The float valve is designed to transfer the fuel from tanks Nos 4, 5 and 6 into tank No.2.

In the lower part of the tank is installed a float pick-up of emergency fuel remainder warning unit C31637H.

Tank No.3

Tank No.3 (Fig.59) is located between frames Nos 16 and 20. This tank is a service tank and consists of two halves: upper half 1 and lower half 6 interconnected through pipes 8, one on each side.

The upper half of the tank occupies the space above the air intake duct and is fastened to the fuselage with pins 2 and flush screws 3.

Mounted in the upper portion of the tank is flange 4 of the filling and vent branch pipe. In the upper and lower parts of the tank there are soft connections which serve to receive and secure connecting pipes 8.

The lower part of the tank occupies the space under the air intake duct and is secured to the fuselage by means of pins.

Installed in the lower part of the tank are: negative g compartment 9, pump 495A2 (10), non-return valve 11 (with baffle 12) to which is attached a pipe running from pump 495A2 of tank No.2.

The upper surface of the lower part of the tank bears soft connections. Soft connections 7, of smaller diameter, are designated to vent the lower portion of the tank, the connections of larger diameter receiving connecting pipes 8 to fill the lower portion of the tank with fuel through the upper portion of the tank.

During negative g and inverted flights the lower half of the tank together with the negative g valve (Fig.60) serves as a negative g compartment, connecting pipes serving the purpose of venting. The negative g compartment is designed as follows:

Mounted on the adapter which is secured to the plate is pump 495A2; in normal flight the fuel enters the pump through two holes made in the body of the negative valve.

Attached to the valve body inside the compartment on a lever is a special load. The other end of the lever is connected with the valve which displaces in the lower hole.

During short inverted flights or during flights under negative g conditions the load will displace towards the air intake duct, and the valve will close the lower

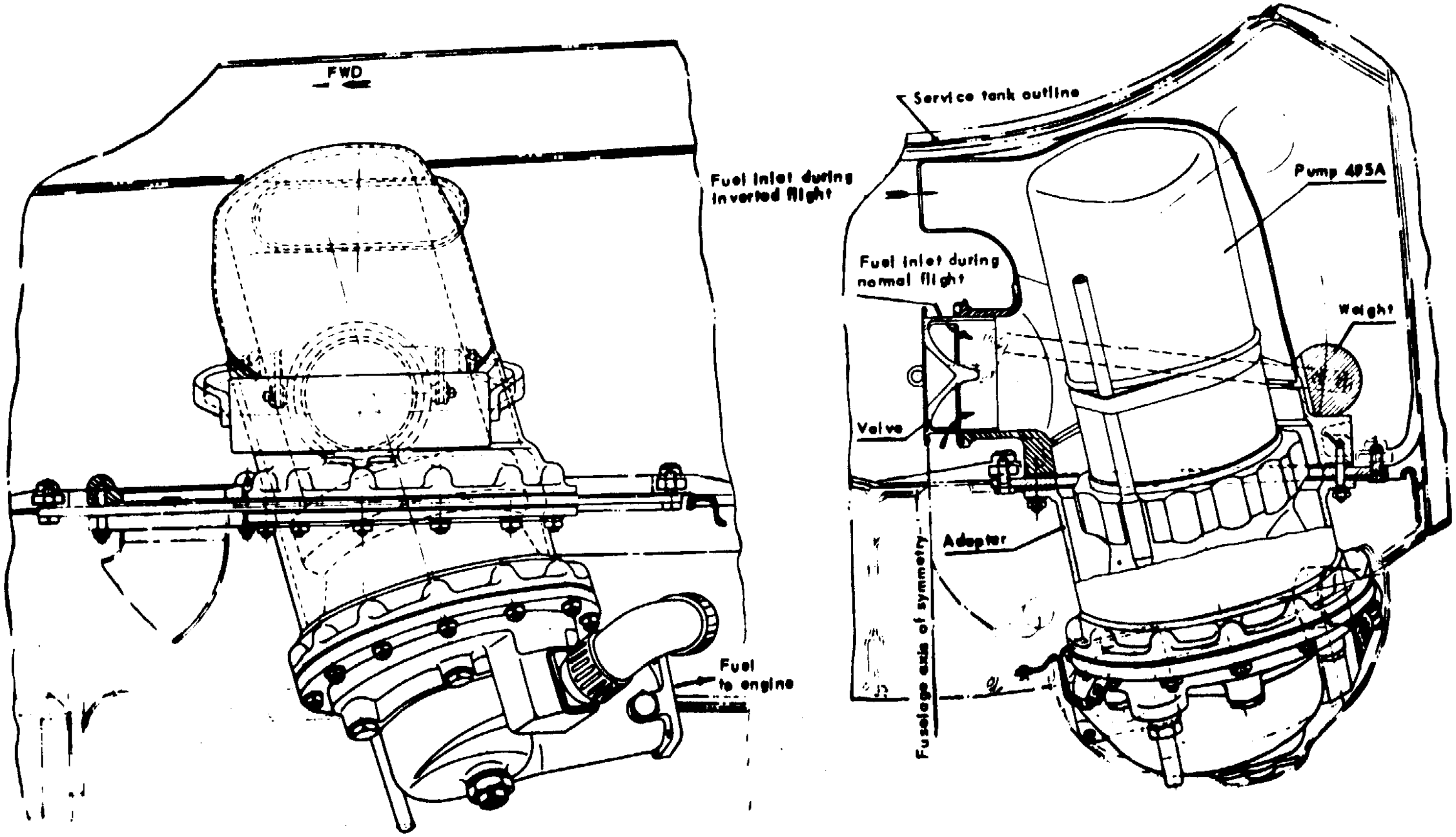

FIG.60. INVERTED FLIGHT VALVE

hole. The fuel will enter the pump through the upper hole which in this case is surrounded by fuel.

Tank No.4

Tank No.4 is located between frames Nos 20-22 above the air intake duct; its cross-section has the shape of a half-ring (Fig.61).

The tank is installed in the fuselage where it is secured by means of pins 3 and is additionally supported with brackets which are installed at the places where the units are mounted.

Besides, the tank is supported at the places where units and assemblies are mounted. The tank mounts the following units: in the upper portion - soft connection 1 to vent the tank and soft flange 2 to attach the branch pipe delivering fuel from tank No.7; in the lower portion - booster pump 5 (495A2) used to transfer fuel from the 3rd group of tanks; the pump is secured to the tank flange (See the view along arrow A) by aid of bolts.

Flanges 6 made into the tank bottom at its front wall are used to mount the connecting pipe. Soft connections 4 on the rear wall of the tank are intended to receive branch pipes connecting tank No.4 with tank No.5.

Tank No.5

Tank No.5 is located in a container above the engine compartment between frames Nos 22 and 25 (Fig.62). The tank is divided along its line of symmetry into two parts: right-hand part 1 and left-hand part 6, each part of the tank being installed in the container separately.

Each half of the tank is secured to the fuselage by means of pins 5; fasteners 4 are used to attach both halves of the tank to the fuselage beam along the line of symmetry (See view along arrow A).

In their upper parts the tank halves are interconnected through vent pipe 2 inserted into soft connections 3.

The tank bottom bears flanges 7 for attaching the fuel system connections.

Tank No.6

Tank No.6 is located in the container above the engine compartment between frames Nos 25 and 28 (Fig.63).

Similar to tank No.5, tank No.6 consists of two halves: the right-hand and the left-hand. Each half of the tank is installed in the container separately.

Both the halves of the tank are secured to the fuselage by means of pins 5; fasteners 4 are used to attach both the halves of the tank to the fuselage beam along the line of symmetry, same as in tank No.5.

Both halves of the tank are vented through pipe 2 inserted and secured in soft connections 3. In the upper section of the left-hand half of the tank there is soft connection 7 used for additional filling from tank No.7.

In the lower wall of the tank there is flange 8 used to install the branch pipes connecting both halves of the tank with tank No.5.

Tank No.7

Tank No.7 of saddle type is arranged on top the aircraft; the tank outline is a continuation of the canopy outline (Fig.64).

The tank is secured to the fuselage structure by means of bolts 22, 27 in four places: along frame No.13 on the right- and left-hand sides by bolts 27,

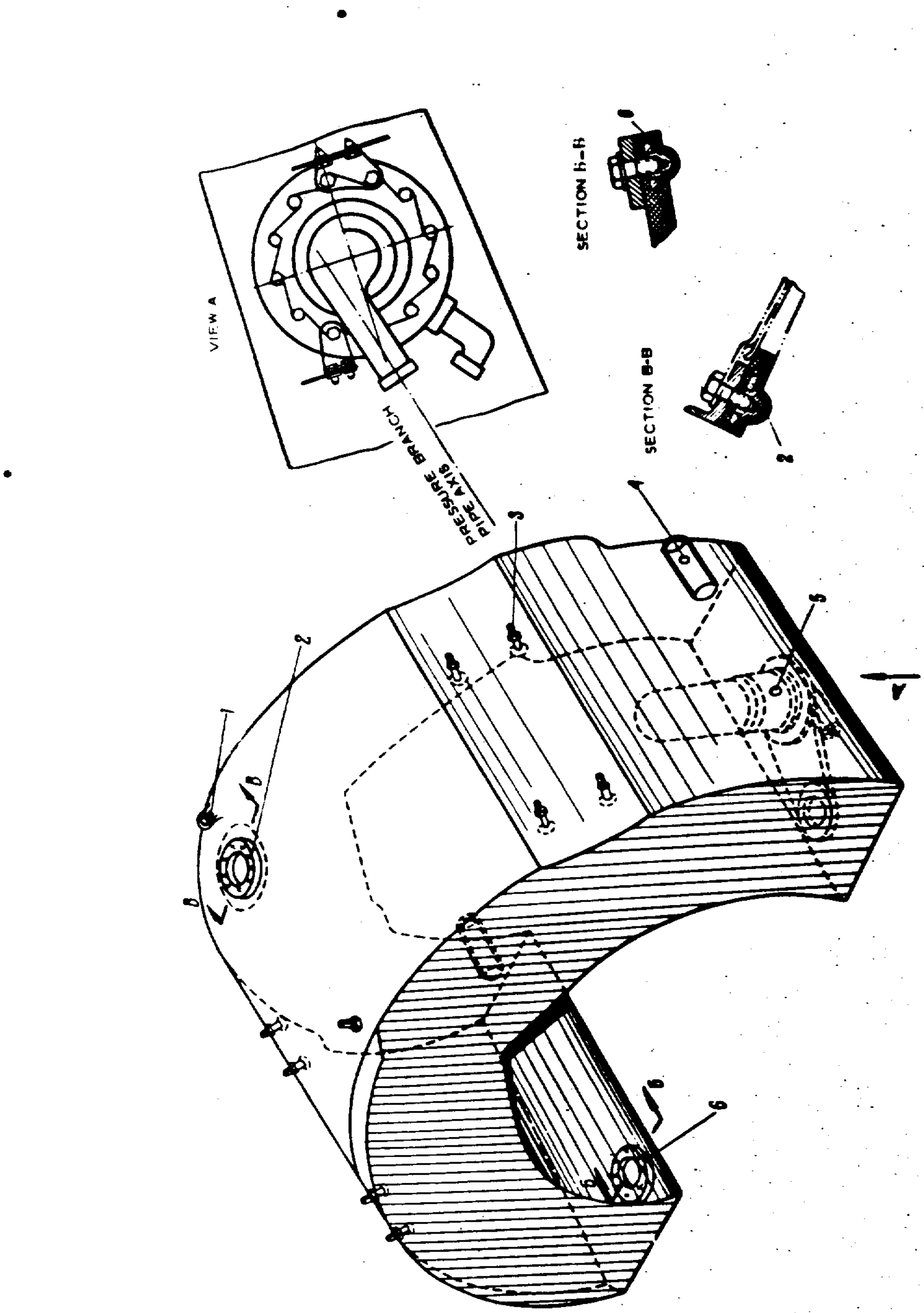

FIG.61. TANK No.4

1 – soft connection; 2 – flange; 3 – pin; 4 – soft connection; 5 – pump 495A2; 6 – flange.

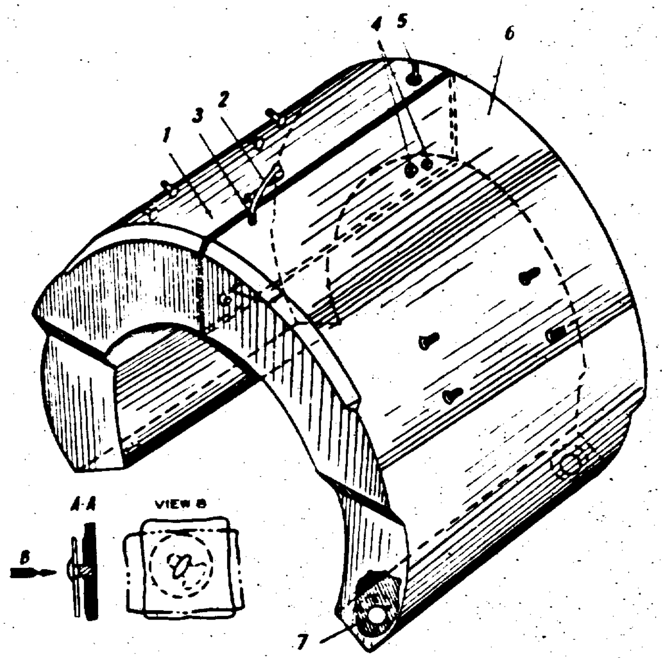

FIG.62. TANK No.5
1 – tank right-hand portion; 2 – vent pipe; 3 – soft connection; 4 – fasteners; 5 – pan; 6 – tank left-hand portion; 7 – flange.

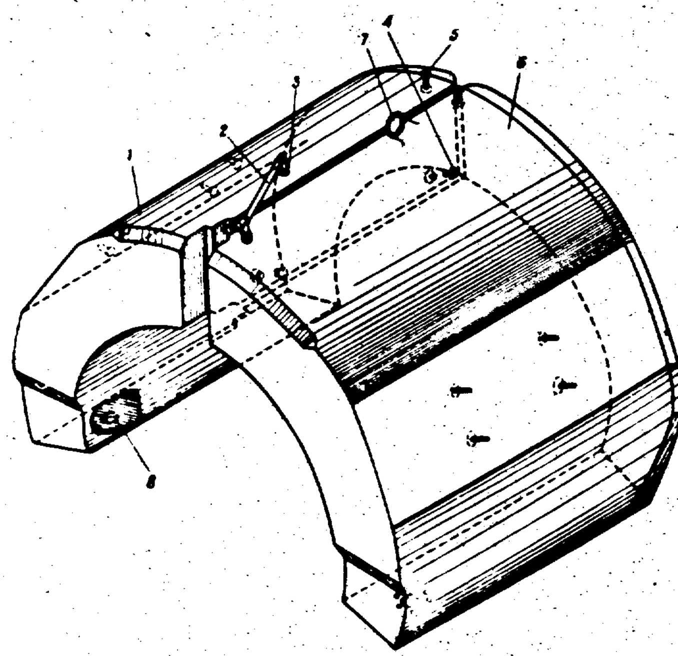

FIG.63. TANK No.6
1 – tank right-hand portion; 2 – vent pipeline; 3 – soft connection; 4 – fasteners; 5 – pan; 6 – tank left-hand portion; 7 – soft connection; 8 – soft flange.

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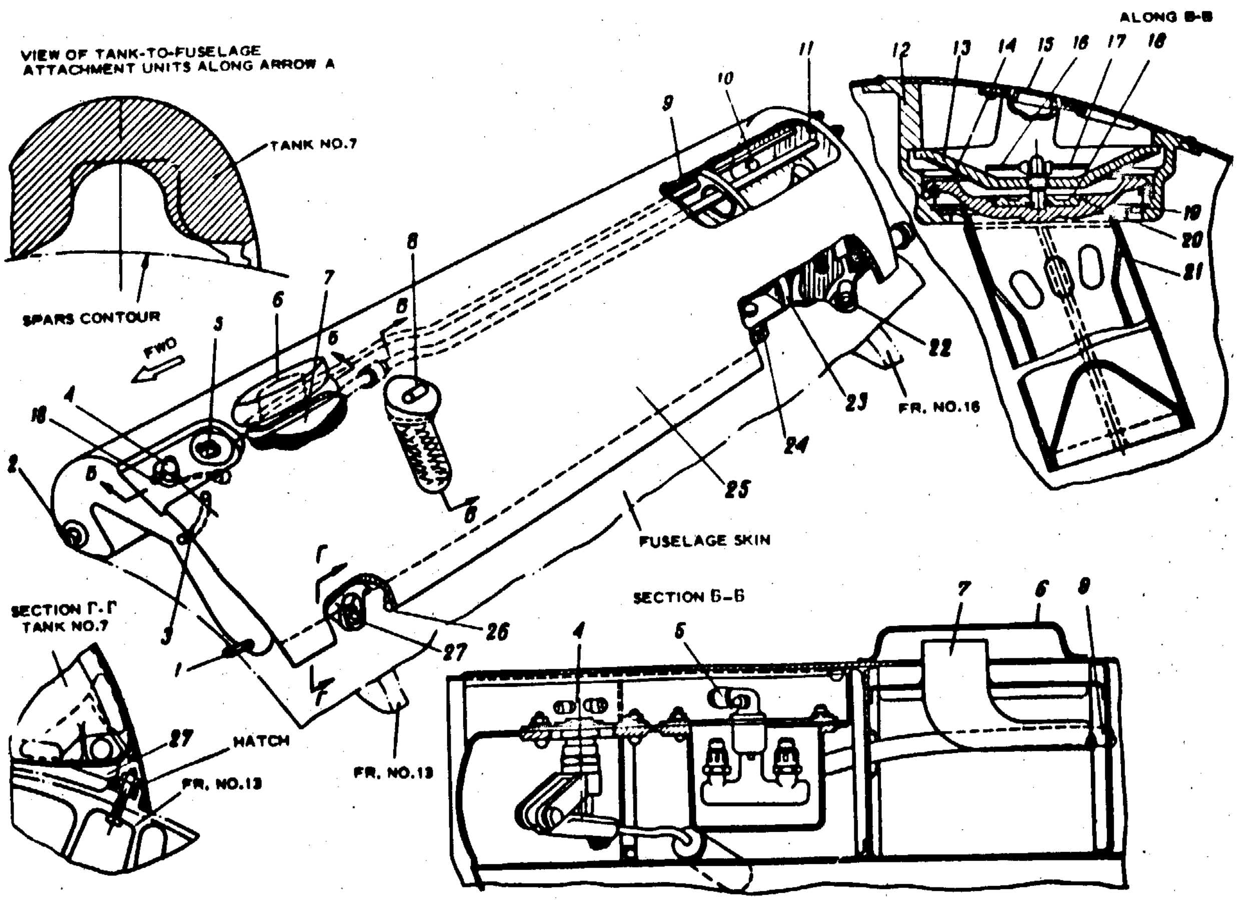

FIG.64. TANK No.7

1 – fuel consumption connection; 2 – branch pipe; 3 – vent pipe; 4 – float valve; 5 – safety valves box; 6 – baffle; 7 – fuel system vent pipe; 8 – filler neck; 9 – vent pipe of safety valves box; 10 – filling connections; 11 – branch pipe; 12 – filler neck body; 13 – crosspiece; 14 – cover; 15 – easily-removable hatch; 16 – strip; 17 – locking washer; 18 – disc; 19 – clip; 20 – locking ring; 21 – gauze filter with funnel; 22 – bolt; 23 – diaphragm; 24 – connection with union nut; 25 – tank skin; 26 – pressurization shape; 27 – bolt.

 ATTACHMENT TO 25X1

and along frame No.16 by bolts 22 (See section along Г-Г). In the tank attachment units along frame No.16 the holes for the bolts are formed by two half-rings of a rectangular section. This is made to exclude stressing of the tank in case of bending deformation of the fuselage. For this purpose when mounting the tank the fastening nuts on frame No.16 are tightened only till the clearance is taken up.

To give access to the attachment units, removable hatches are provided. Installed along the joint line of the tank and the fuselage skin is sealing rubber shape 26. The outside skin is 1.5 mm thick, the skin of the internal arch of the tank being 1.2 mm thick. The load-carrying assembly of the tank includes ten transverse diaphragms 23 and two bottoms: front and rear. Mounted on the front tank bottom are:

(a) connection 1 to attach the pipe connecting the left and right portions of the tank;

(b) connection 2 to attach the filling pipe of tank No.1;

(c) vent pipe 3 to vent tanks No.1 and No.2, soldered to the bottom of the tank.

Mounted in the upper portion of the tank are:

(a) float valve 4 and a set of safety valves 5 in the tank recess closed by a cover (not shown). The safety valves are enclosed in a pressurized box communicating with the common vent system by pipe 9;

(b) fairing 6 forming a cavity to which pipe 7 runs to vent and pressurize all fuselage tanks;

(c) filler neck 8 (See section along B-B).

The rear wall of the tank mounts five branch pipes. Two middle branch pipes (the left-hand and right-hand ones) are the continuation of vent pipes 7 and 9; lower branch pipes 10 (the right-hand and left-hand ones) are intended to connect the filling pipe of tanks No.2, No.3, No.4, No.5 and No.6, upper branch pipe 11 connecting the vent pipe of the 3rd tank of the rear group of tanks and the pipe from the wing tank vent valve. The pipe with union nut 24 on the lower portion of the tank is intended to allow fuel flow from tank No.7 into tank No.2 when filling and consuming the fuel.

The safety valves unit installed on the tank is used to maintain the constant value of excessive pressure in the wing tank compartments.

The safety valves start opening at a pressure of 0.12 to 0.2 atm. gauge. Together with a throttle of the 2 mm dia. the safety valves maintain the excessive pressure in the wing tank compartments at 0.12 to 0.2 atm. gauge relative to the pressure in the fuselage tanks.

Drop Tank

The drop tank (Fig.65) has the shape of a cylinder with tapered ends.

The tank is suspended from the pylon under the fuselage by means of a 369E bomb rack shackle and may be dropped during the flight, if necessary.

The tank is welded of AMT material and has a stressed skin. The tank consists of three parts: front part 1, middle part 7 and rear part 10 butt-welded to each other.

Front part 1 of the tank is the tank tapered portion. It has three internal stiffeners made of stamped sections which are welded to the skin by continuous welding.

The middle portion of the tank has hermetically sealed partition 15 at one end and two load-carrying shapes 20, at the other, with front rest 4 arranged between them.

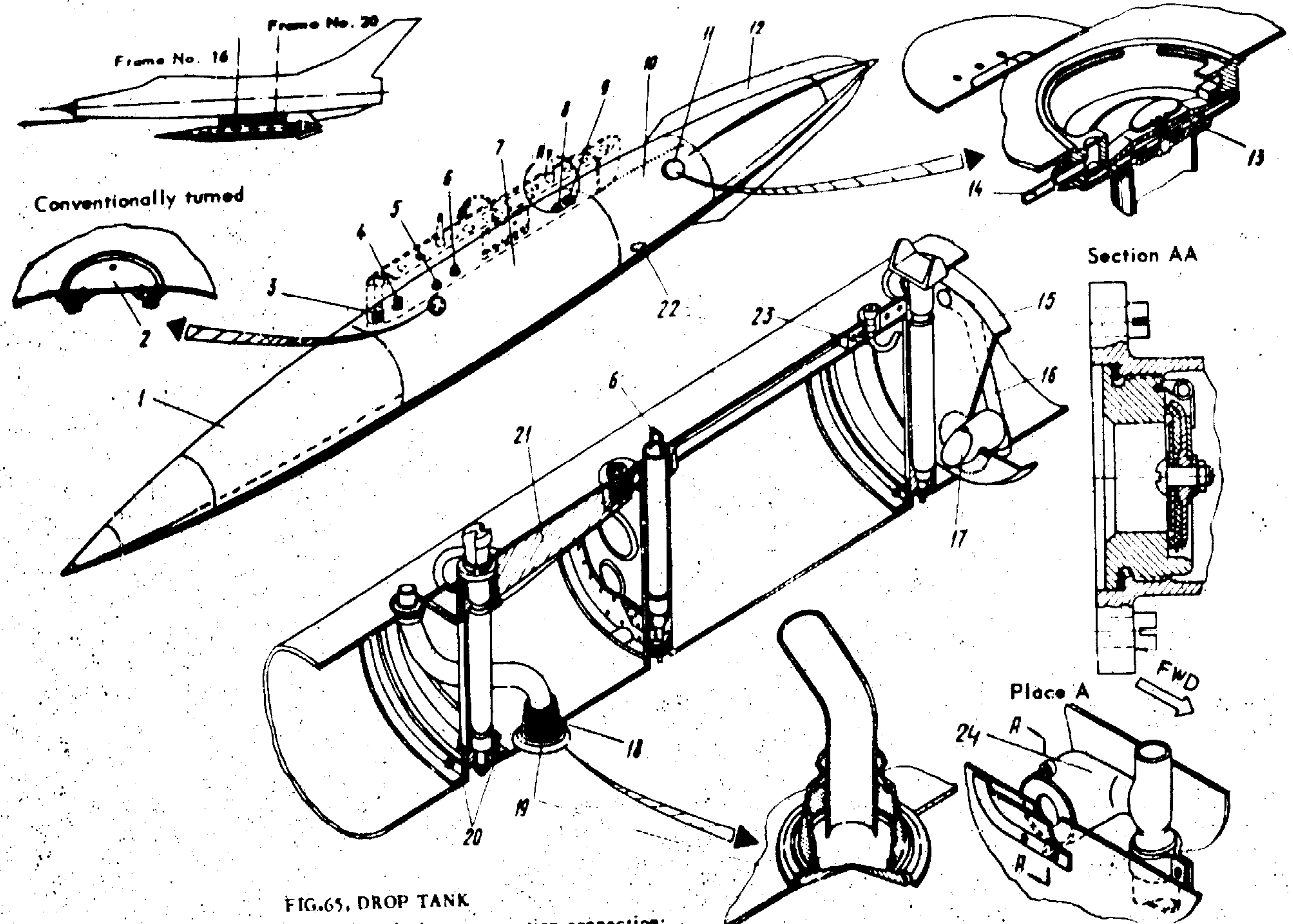

FIG.65. DROP TANK

1 – tank front part; 2 – drain neck; 3 – consumption connection; 4 – front rest; 5 – bushing for explosive pusher; 6 – eye-bolt; 7 – tank middle part; 8 – pressurization connection; 9 – rear rest; 10 – tank rear part; 11 – filler neck; 12 – stabilizer plates; 13 – neck crosspiece; 14 – vent pipe; 15 – partition; 16 – by-pass pipe; 17 – non-return valve; 18 – gauze filter; 19 – drain plug cover; 20 – shapes; 21 – beam; 22 – drain plug; 23 – pressurization pipe; 24 – vacuum valve.

[redacted]

Located on the middle straight portion of the tank are front rest 4, rear rest 9 and eye-bolt 6 by means of which the tank is secured to the pylon. The sam portion of the tank accommodates oil consumption pipe union 3, pressurization con-nection 8 and drain neck 2 for emptying the tank by the refueling truck.

Front rest 4 serves to hold the tank against displacement in the horizontal and upward directions, rear rest 9 holds the tank from displacement in the side an upward directions. Eye-bolt 6 keeps the tank from displacement downward. Load-car-rying beam 21 is arranged between the front rest and the eye-bolt in the upper par of the tank. Mounted on beam 21 is bushing 5 for the explosive charge actuated pusher.

Rear part 10 of the tank consists of a cylindrical portion and tapered end with three internal stiffeners welded to the shell.

The rear end of the tank is equipped with filler neck 11, drain plug 22 and four stabilizer plates 12 arranged at equal distances along the perimeter of the r end of the tank.

The tank is filled with fuel through filler neck 11 located in the upper par of the rear compartment. The front compartment of the tank is filled with fuel fm the rear compartment through a branch pipe with non-return valve 17 installed in the bottom part of hermetically sealed partition 15.

During refueling the air leaves the upper part of the front compartment through the filler neck along vent pipe 14 running inside the tank. The pipe is automatically closed by crosspiece 13 as soon as the filler is closed.

In the course of fuel consumption the fuel is forced out of the drop tank by the excessive pressure of the air fed from the engine compressor through pressuriz-tion connection 8 and further along pipe 23 to the rear part of the tank. From the rear part of the tank the fuel is forced out into the front part of the tank through non-return valve 17 and from there to the second fuselage tank through gauze filter 18 along the internal pipeline running inside the tank and pylon.

By-pass pipe 16 is installed in the sealed partition parallel to the branch pipe with the non-return valve. This pipe is intended to reduce saturation of the fuel in the front compartment with air coming through non-return valve 17 from the rear compartment after the fuel has been consumed from this compartment. Owing to this pipe, part of the air is directed upward for pressurizing the front compart-ment, by-passing the non-return valve.

The pipeline connecting the drop tank with tank No.2 is fitted with two non-return valves to ensure reliable closing of the fuel pipe after the drop tank is jettisoned.

Gauze filter 18 installed at the end of the delivery pipeline is secured to drain plug 19 which is screwed into the tank flange. To remove the filter for clea-ing it is necessary to turn out the drain plug together with the filter.

Drain neck 2 on the middle part of the tank serves to empty the tank into the tank of the refueling truck. In transportation of the tank the neck is used for keeping the parts of the explosive pusher which are placed in a special capsule.

To avoid rarefaction in the tank during diving the air supply pipe on the pylo is equipped with a vacuum valve which opens when a rarefaction of 0.03 kg/cm^2 is created in the tank relative to the ambient air.

During the flight the tank can be dropped with the aid of electric jettisoning mechanisms located in the drop tank pylon (for details see Technical Description, Book II).

[redacted]

In jettisoning the tank the electric mechanism releases the hook of the bomb rack to which the tank is attached by means of an eye-bolt; then the explosive charge actuated pusher detaches the tank from the pylon.

The correct position of the tank at the moment it is jettisoned is ensured by the guide in the rear rest and by the stabilizers on the rear end of the tank.

III. OXYGEN FEED SYSTEM FOR ENGINE STARTING IGNITERS

Wiring and Schematic Diagrams

To ensure reliability of engine restarting in flight, especially at high altitudes, use is made of an automatic oxygen feed system serving to supply oxygen to the starting igniters of the main combustion chambers. The oxygen feed system (Fig.66) is an independent system which is not connected with the oxygen system of the pilot. The system consists of the following components:

(1) two-litre oxygen bottle 6 installed in the wing in front of the main beam in the vicinity of rib 1;

(2) oxygen reducer 11, type 2130A, installed on the L.H. side of the fuselage near frames Nos 16 and 17 in the wheel well on the wall of the container for tank No.3;

(3) electropneumatic valve 5, type 694400, used to feed oxygen to the engine; this valve is installed in the L.H. wheel well on frame No.20;

(4) aircraft charging connection 8, type 11180, and high-pressure gauge 7, type MK-12M, installed on the L.H. wing, in the vicinity of ribs 2 in the L.G. well (pressure gauge MK-12M is designated to check the pressure in the bottle when the latter is being charged);

(5) oxygen valve 2 used to feed oxygen from the bottle into the system;

(6) low-pressure gauge 1, type MK-16, intended to check the pressure of oxygen after the reducer;

(7) electric control system of oxygen supply to the engine.

The system operates in the following way: oxygen bottle 6 is charged through connection 8 (see the Schematic Diagram) up to a pressure of 130-150 atm. gauge as checked by pressure gauge 7.

Before taking off oxygen valve 2 opens and the oxygen enters high-pressure reducer 11, the oxygen pressure drops to $10^{+0.5}_{-1.0}$ atm. gauge and is fed further to electropneumatic valve 5.

When the engine is restarted in the air (switch IN-FLIGHT RESTARTING is in the ON position), the current is automatically supplied to the electromagnet windings of electropneumatic valve 5, causes the valve to open and permits flow of the oxygen to the starting igniters through non-return valve 3 installed on the engine. At this moment gasoline is fed to the starting device which makes the restarting of the engine in the air more reliable.

When the engine is started on the ground by pressing button ENGINE STARTING (ЗАПУСК ДВИГАТЕЛЯ), no current is supplied to the terminals of the electropneumatic valve and the latter does not open.

When checking the system for leakage with the help of nitrogen electropneumatic valve 5 can be opened: for this purpose tumbler OXYGEN FEED TO ENGINE (КИСЛОРОДНАЯ ПОДПИТКА ДВИГАТЕЛЯ) placed on the L.H. side of the fuselage near frames Nos 12 and 13, must be set in position CHECK (ПРОВЕРКА). In this case do not fail to switch on circuit breaker STARTING UNITS (АГРЕГАТЫ ЗАПУСКА).

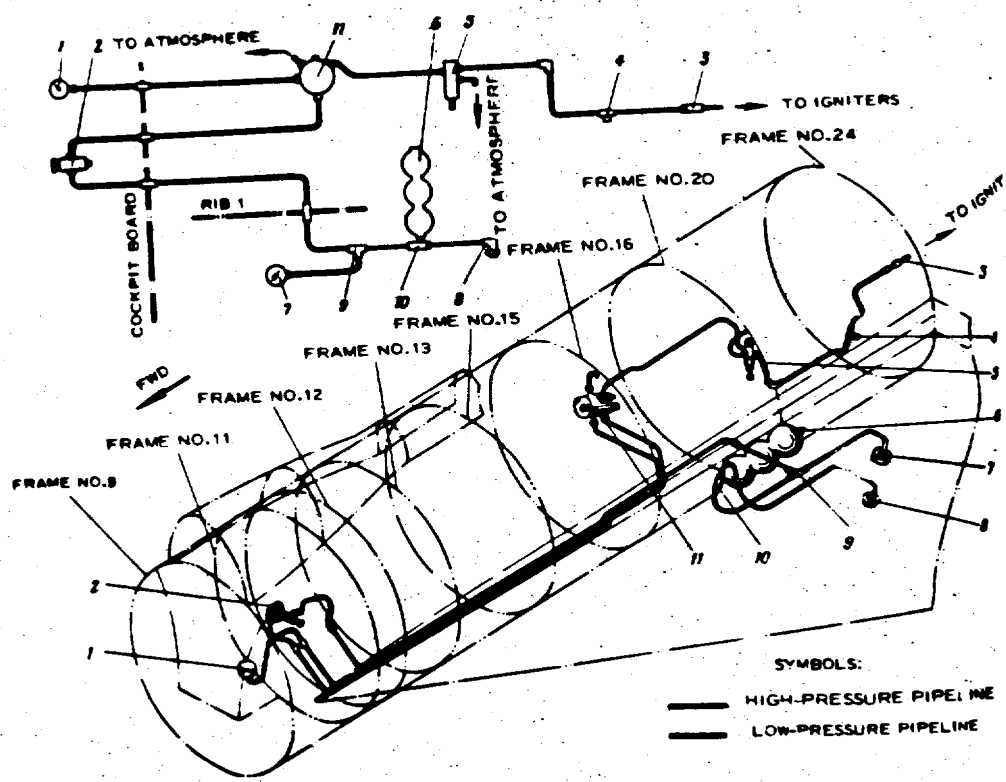

FIG.66. OXYGEN FEED SYSTEM ARRANGEMENT AND SCHEMATIC DIAGRAMS
1 – pressure gauge MK-16; 2 – oxygen valve KB-2MC; 3 – non-return valve; 4 – T-piece; 5 – electropneumatic valve 694400; 6 – oxygen bottle; 7 – pressure gauge MK-12M; 8 – charging connection; 9 – T-piece; 10 – return valve; 11 – oxygen reducer 2130A.

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To check the oxygen feed system on the ground at the end of engine running just before the engine stops, restart it with the switch bearing the inscription IN-FLIGHT RESTARTING.

The testing sequence is described in the Maintenance Instructions for the ГК-076 unit.

Oxygen Pressure Reducer

The oxygen reducer, type 2130A (Fig.67), is designated to reduce the pressure of oxygen fed to the reducer at a pressure of 150 - 25 atm. gauge to $10^{+0.5}_{-1}$ atm. gauge at the reducer outlet and to maintain this pressure at a constant value.

The reducer is of a single-stage reverse-action type. Reducer body 2 has three chambers: high-pressure chamber A, working pressure chamber B and safety valve chamber C. Pressed into the reducer body is reducing valve seat 7 and safety valve seat 17.

Ball 6 is pressed to seat 7 through valve 5 by means of spring 4. Spring 4 is pressed from top through plate 3 by plug 1 screwed into the reducer body.

Tappet 9 is pressed to ball 6 from below by sylphon 11. The sylphon is welded to bushing 10 and flange 13 which is bolted to the body. Inserted into sylphon 11 is spring 12 pressed by plug 14.

Chamber C accommodates safety valve 20 consisting of ball 18, seat 17, smaller sylphon 19, and springs 21 and 16. Eyes 15 and 22 serve for attachment of the reducer on the aircraft.

The reducer operates as follows: during operation the oxygen pressure at the reducer inlet is 150 - 25 atm. gauge and at the reducer outlet it is maintained within $10^{+0.5}_{-1}$ atm. gauge. At the moment oxygen consumption begins, the pressure in chamber B drops. Sylphon 11 is expanded by spring 12 and forces ball 6 away from seat 7. The oxygen passes through the annular slot formed between the ball and the seat. Spring 4 as well as the pressure of the oxygen on the top of sylphon 11 and the pressure of spring 12 on the bottom of the sylphon bring ball 6 into a state of equilibrium ensuring a constant pressure of the oxygen at the outlet, while the pressure at the inlet changes from 150 to 25 atm. gauge.

In case the pressure at the outlet of the reducer exceeds the permissible value of 12^{+4} atm. gauge, sylphon 19 contracts, spring 16 presses ball 18, and a passage is formed between the ball and seat 17 through which the oxygen is released into the atmosphere. As the pressure drops down to 12 atm. gauge again, sylphon 19 is expanded by spring 21 and presses ball 18 to seat 17, thus closing the passage for the oxygen.

The oxygen pressure reducer requires no adjustment during service.

Oxygen Valve КВ-2МС

The purpose of the oxygen valve (Fig.68) is to disconnect the oxygen bottle from the oxygen system.

The valve is opened before taking off and is closed after landing. This prevents leakage of oxygen through the reducer and through those places of the system which may be leaky.

Inserted into valve body 1 is valve 8 with spring 9. The valve is pressed to the seat of the body from top by segment 3 through membrane 2. The segment is inserted into spindle 5. The valve is closed when it is in this position. The valve is opened by turning handwheel 6 until it rests against plug 4.

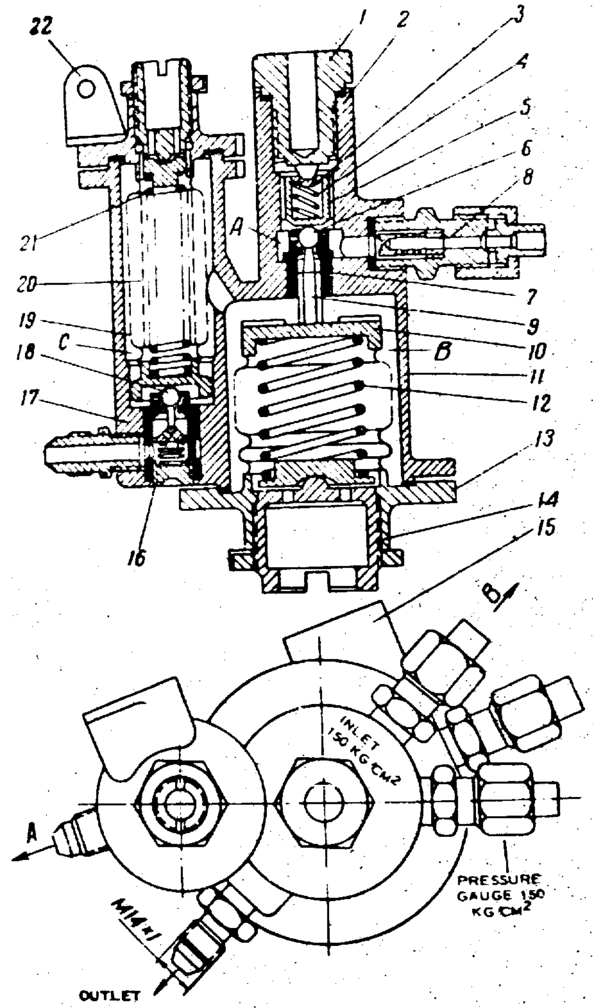

FIG.67. OXYGEN REDUCER 2130A
1 – plug; 2 – body; 3 – plate; 4 – spring; 5 – valve; 6 – ball; 7 – seat; 8 – connection; 9 – tappet; 10 – bushing; 11 – sylphon; 12 – spring; 13 – flange; 14 – plug; 15 – eye; 16 – spring; 17 – safety valve seat; 18 – ball; 19 – sylphon; 20 – safety valve; 21 – spring; 22 – eye.

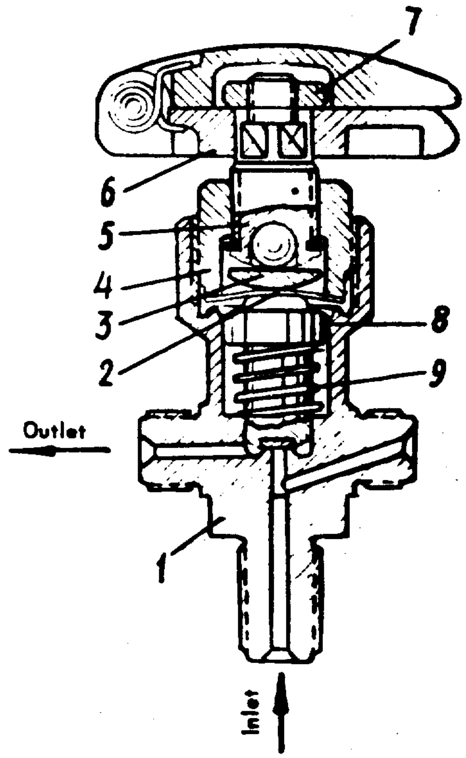

FIG.68. OXYGEN VALVE KB-2MC
1 – body; 2 – membrane; 3 – segment;
4 – plug; 5 – spindle; 6 – handwheel;
7 – nut; 8 – valve; 9 – spring.

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IV. ENGINE CONTROL SYSTEM

Engine control (Fig.69) is accomplished with the help of the engine control lever on the throttle control. The throttle control is arranged on the L.H. console inside the cockpit at frame No.8.

The engine control lever is connected with the control mechanism lever on the ПУРТ-10 control panel of the engine by means of rigid rods and bell-cranks installed at frames Nos 11-22.

Besides the bell-cranks, the engine control system employs supports which are installed at frames Nos 15 and 17.

The engine controls are passed through the cockpit walls with the aid of a sealing unit located at frame No.11 at the bottom (Fig.70).

Engine control rod 1 is pressure-sealed with the help of bushing 2 and sealing boot 3. The latter is secured to bushing 2 by means of wire band 10. The other end of the sealing boot is attached to connection 9 by means of collar 8. Connection 9 is in its turn rigidly connected to frame No.11.

Bushing 2 has an annular slot packed with grease ЦИАТИМ-221 and covered on top with a collar protecting the sealing surface from dirt, dust and moisture.

Bushing 2 is supported by a hinged appliance consisting of bracket 4 riveted to the cockpit floor, shackle 5, clamps 6 and 7 which make a hinge connection between bushing 2 and bracket 4. Due to this design rod 1 may assume an inclined position when it moves in the vertical plane.

The throttle control (Fig.71) comprises a bracket, engine control lever, holding knob and other attachment parts.

Mounted on the bracket are: CUT-OFF (СТОП) and IDLING (МАЛЫЙ ГАЗ) position retainer and stops of rating MAXIMUM (МАКСИМАЛ), MINIMUM AFTERBURNING (МИНИМАЛЬНЫЙ ФОРСАЖ) and FULL AFTERBURNING (ПОЛНЫЙ ФОРСАЖ).

On the control lover are arranged the retainer for positions MAXIMUM, MINIMUM AFTERBURNING and FULL AFTERBURNING and also stop IDLING RATING and CUT-OFF.

The body of the engine control lever mounts the air brake microswitch slide and the radio set switch button.

When the holding knob is turned clockwise, the travel of the engine control lever becomes more difficult. This allows the pilot to free his left hand from the lever at steady engine ratings.

Positions CUT-OFF and IDLING are fixed by the retainer secured on the throttle control bracket and by the stop on the engine control lever.

When the CUT-OFF position retainer is pressed, the control may be removed from the CUT-OFF stop and shifted to position IDLING and vice versa.

Positions MAXIMUM,MINIMUM AFTERBURNING and FULL AFTERBURNING are fixed by a retainer secured to the control lever and by the stops attached to the throttle control bracket.

Position MAXIMUM is fixed by the released retainer when the engine control lever is pushed forward, whereas the MINIMUM AFTERBURNING position is fixed when the engine control lever is pushed backward.

The FULL AFTERBURNING rating is selected by pressing the same retainer and pushing the engine control lever as far as it will go forward; the retainer fixes the lever in the FULL AFTERBURNING position.

The P11Ф2-300 engine installed on the aircraft is fitted with a rod control system for the augmented ratings within the range from the MINIMUM AFTERBURNING position of the engine control lever to the FULL AFTERBURNING position. For this purpose the engine is equipped with a follow-up system, type ЭГСУ-1А, for flaps

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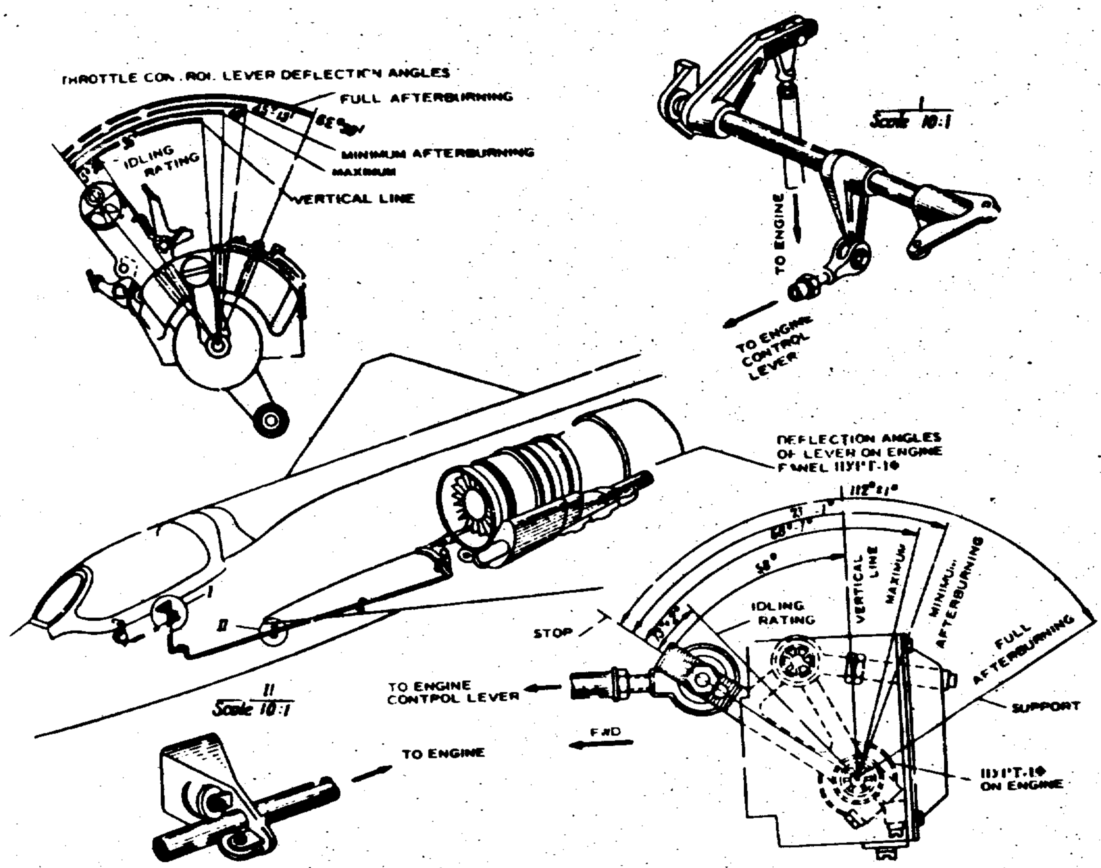

FIG.69. ENGINE CONTROL DIAGRAM

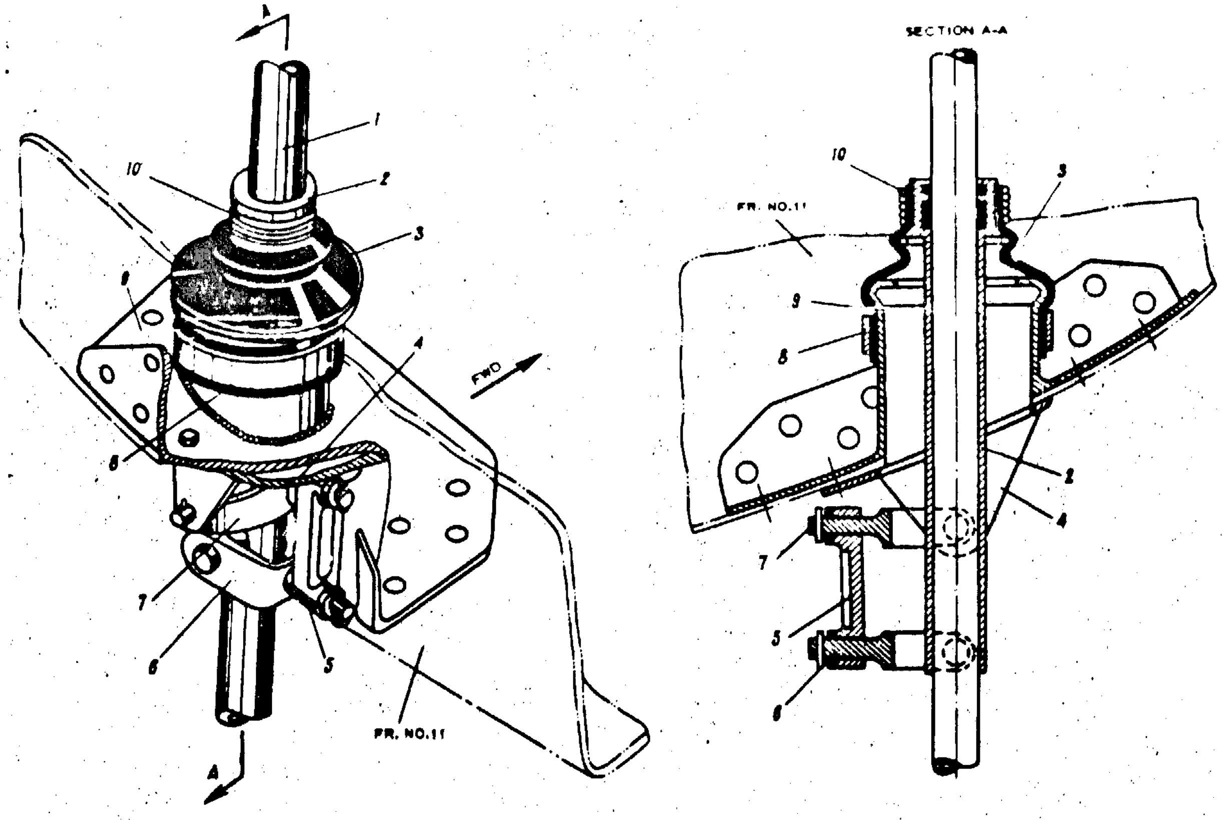

FIG.70. PRESSURE SEALING UNIT
1 – engine control rod; 2 – bushing; 3 – sealing boot; 4 – bracket; 5 – shackle; 6 – clamp; 7 – clamp; 8 – collar; 9 – sealing connection; 10 – wire bead.

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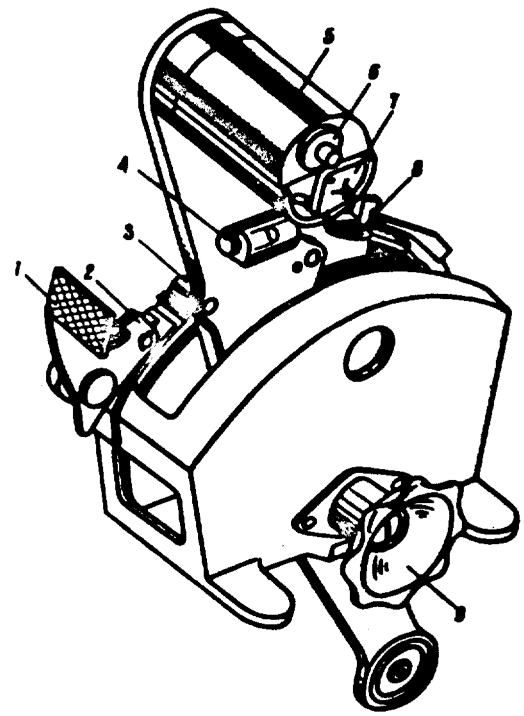

ARRANGEMENT OF THROTTLE CONTROL STOPS

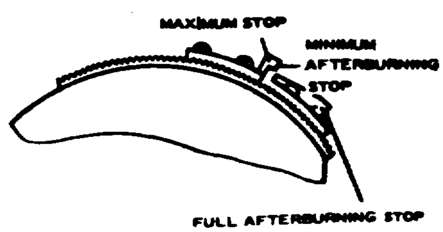

FIG.71. THROTTLE CONTROL

1 – retainer of CUTOFF and IDLING stops; 2 – IDLING stop; 3 – CUTOFF stop; 4 – light; 5 – engine control lever handle; 6 – radio set transmitter button; 7 – slider of air brake microswitch KB-9; 8 – retainer of MAXIMUM, MINIMUM AFTERBURNING and FULL AFTERBURNING stops; 9 – tightening handwheel

control (the description of the design and principle of operation of the ЗГСУ-1А system are given in the Description of the engine).

In case the ЗГСУ-1А system fails, provision is made for emergency control of the jet nozzle flaps.

The jet nozzle flaps emergency control system is engaged by cutting in the switch with the inscription NOZZLE EMERGENCY CONTROL (АВАРИЙНОЕ УПРАВЛЕНИЕ СОПЛОМ).

With the throttle control lever in the augmented rating range, the nozzle flaps close when switch NOZZLE EMERGENCY CONTROL is switched on. When the engine control lever is placed within the range from the idling rating to $n = 66^{+2}_{-1}$ % of the high-pressure rotor, the flaps take a fully open position (flap dia. = 675 - 10 mm). As the engine control lever is being shifted toward 75° by the dial of panel ПУРТ-1Ф, the flaps move to take a fully closed position (flap dia. = 530 mm). The minimum augmented rating is switched on at 73 - 78° as indicated by the dial of panel ПУРТ-1Ф (flap dia. = 610 mm). The augmented rating is controlled within the range of from 78 to 108°; in this case the flaps will take an intermediate position. When the lever is set at stop FULL AFTERBURN. (108 to 112° by the dial of panel ПУРТ-1Ф), the flaps will take a fully open position (Fig.72).

To check the engine operation the following instruments are made use of:

1. Two generators ДТЭ-1 of the engine tachometer: one generator of L.P. rotor r.p.m. is arranged at frame No.22 to the right, below, whereas the other generator of the H.P. rotor r.p.m. is located to the left between frames Nos 25 and 26.

The ИТЭ-2 engine tachometer indicator is arranged on the instrument board in the cockpit.

2. A set of ТВГ-190 thermocouples for measuring the gas temperature after the turbine.

3. A set of ДИМ-8Т electric pressure gauges for measuring oil pressure at the engine inlet.

The pick-up of the pressure gauge is mounted on the engine to the right in the vicinity of frames Nos 23-24, whereas the indicator is located on the instrument board in the cockpit.

V. FIRE-FIGHTING EQUIPMENT

The fire-fighting equipment is designed to detect and extinguish fire in the engine compartment.

The fire-fighting equipment system is shown in Fig.73.

It comprises the following units:

(a) ion fire detector ИС-2МС;

(b) 2-lit. cylinder 6, type 2ОС-2М-1С, with squib 12 installed in the discharge bonnet.

The cylinder is located on frame No.20 in the right wheel well;

(c) steel discharge ring 8 with orifices, 1.7 mm dia., installed on frame No.2[illegible]

(d) electric system for warning the pilot about fire and for bringing the fire-fighting equipment into action.

The fire detector sensitive unit is a metal heat-resistant tube 7 installed on special ceramic insulators.

There are two such detectors in the system. They are installed symmetrically on the engine on top and bottom relative to the engine reference line at frames Nos 2[illegible]

The ИС-2МС fire detector operating principle is based on the flame capability to conduct electric current. This property can be explained by ionization which takes place simultaneously with the chemical reaction at flame outbreak. That is why the fire detector operates only in case of flame formation and does not respond to a mere rise of ambient air temperature.

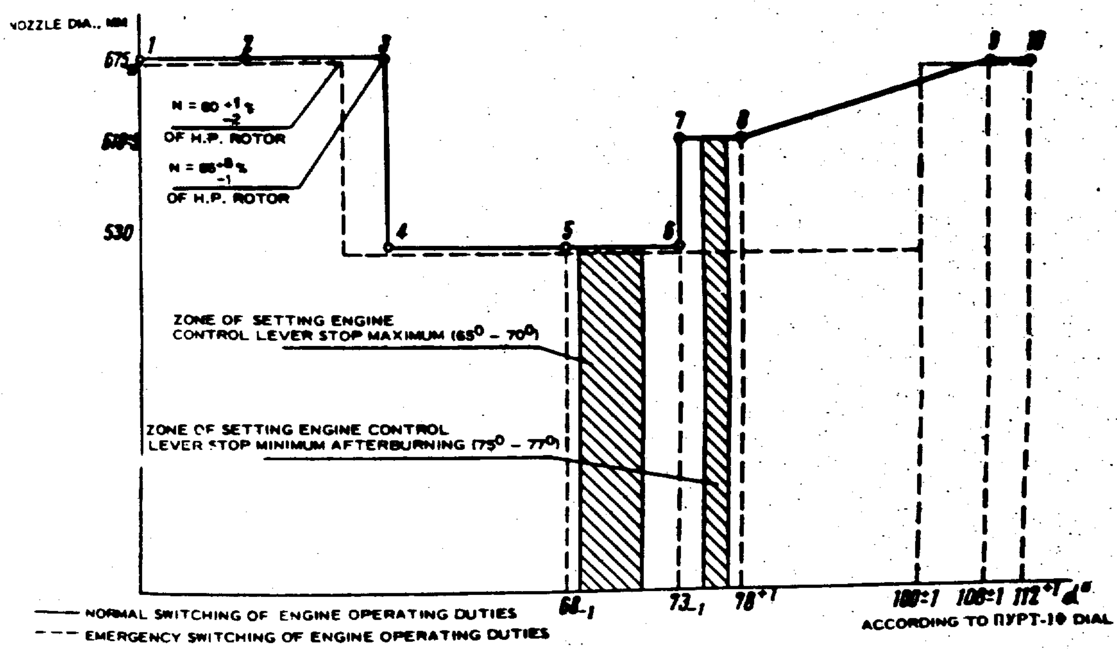

FIG.72. CHART OF ENGINE OPERATING DUTIES

1 – beginning of engine starting; 2 – IDLING; 3, 4 – closing of flaps with engine control lever shifted forward; 5 – MAXIMUM switching; 5 – operation of ПК cam; 6 – MINIMUM AFTERBURNING switching; 7 – 8 – MINIMUM AFTERBURNING; 8 – 9 – controlled augmented rating; 9 – 10 – FULL AFTERBURNING.

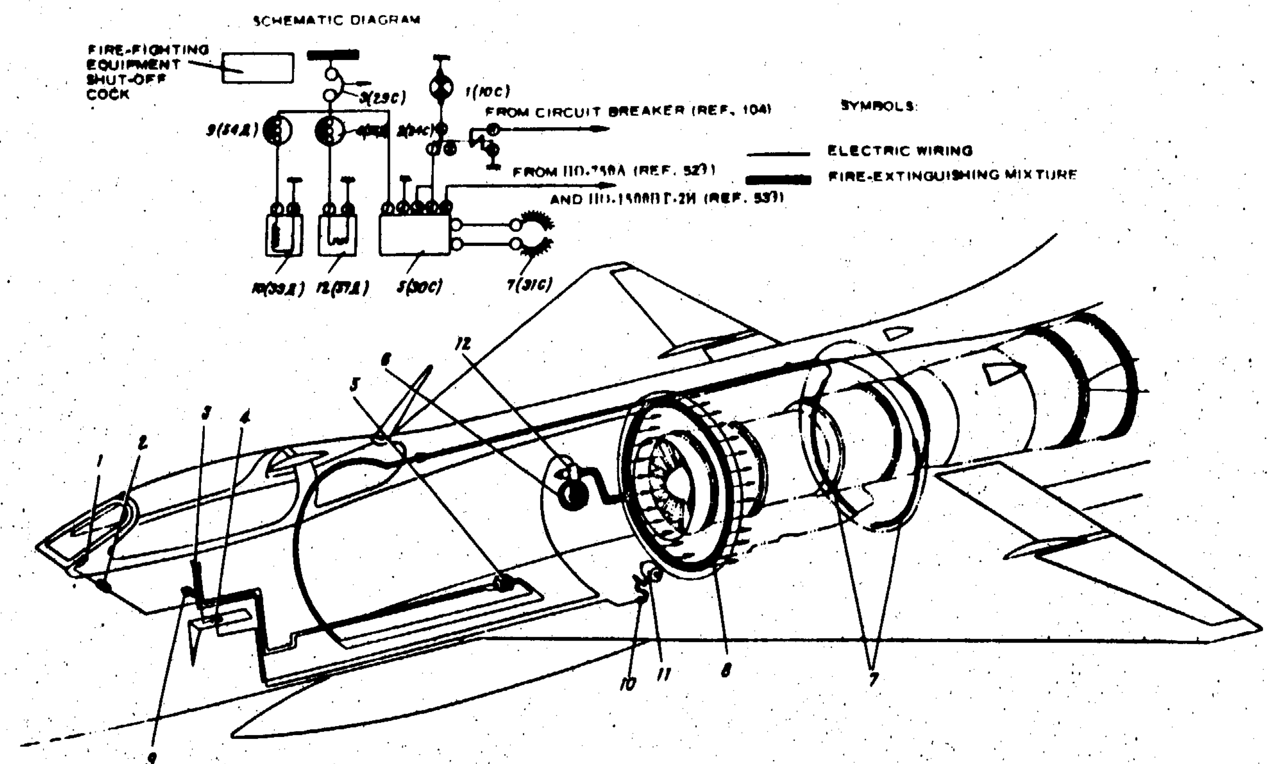

FIG.73. FIRE-FIGHTING EQUIPMENT

1 – warning lamp on light panel 1-103 ; 2 – ТКЕ-56П.1 light panel control relay; 3 – circuit breaker АЗС-5; 4 – 204K fire-extinguishing button; 5 – ПО-2МС ion fire detector; 6 – fire-extinguishing cylinder 20С-2-1С; 7 – ion fire detector sensitive unit; 8 – discharge ring; 9 – 204K button of engine fuel supply shut-off cock; 10 – electropneumatic valve 695000 M; 11 – fuel system cut-off cock; 12 – squib of 20С-2-1С fire-extinguishing cylinder.

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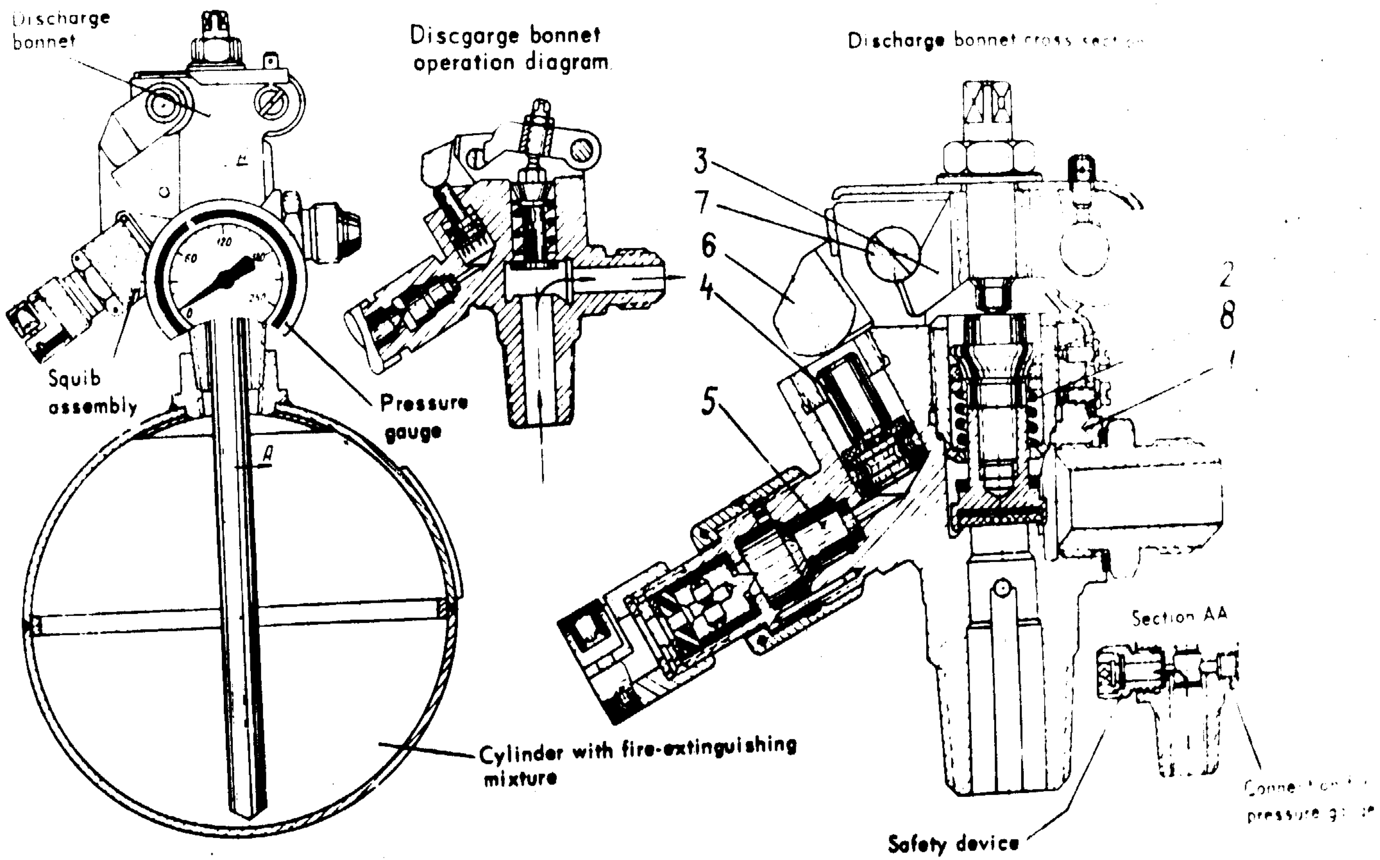

FIG.74. FIRE-EXTINGUISHING CYLINDER WITH DISCHARGE BONNET

1 – discharge bonnet body; 2 – valve; 3 – lever; 4 – piston; 5 – squib; 6 – lever; 7 – axle; 8 – spring

If flame occurs in the space between detector 7 and the engine structure, this air space becomes electro-conductive and closes the circuit of amplifier 5, the air space forming part of the circuit.

Electronic amplifier 5 is included into the system to intensify the current conducted through the air ionized space, as the latter is highly resistive to the current in the circuit.

The transformer primary winding of the amplifier is fed by a 115 V, 400 c.p.s. A.C. from ПО-750А (ПО-1500 ВТ-3И) inverter.

The amplifier grid leads are connected to fire detector sensitive units 7. If flame appears in the space of the sensitive units,the anode current is increased to such a value at which the relay operates and feeds current to warning lamp 1 (bearing inscription the FIRE - ПОЖАР) from the aircraft mains. The current is supplied through circuit breaker 3 (inscribed FIRE-FIGHT. EQUIP. SHUT-OFF COCK - ПОЖ. ОБОРУД. ПЕРЕКРЫВ. КРАН) which should be cut in before flight.

Fed from the same circuit is fuel shut-off cock 11, which becomes closed by depressing button 9 (for details see the fuel system description in Chapter III).

As is evident from the above-mentioned, the ИС-2МС fire detector serves only to give warning signals.

Upon reception of the FIRE (ПОЖАР) signal, the pilot should press button 4 which bears the FIRE-EXTINGUISHER (ОГНЕТУШИТЕЛЬ) inscription and is located on the left-hand console.

With the button pressed, squib 5 placed in the discharge bonnet of cylinder 12 explodes (Fig.74). Gases, resultant from the squib burning, enter the space under piston 4 which by means of its rod turns lever 6 fitted on semi-circular axle 7.

The free end of lever 3 bears against semi-circular axle 7 so that when the latter is being turned, lever 3 begins to rotate and valve 2, which is always under the action of spring 8, opens and passes the fire-fighting liquid into discharge rings 8 (See Fig.73), whence it is discharged through orifices into the space between the engine and fuselage.

Installed on the discharge bonnet are a pressure gauge rated for 250 atm. gauge and a safety device. In case of pressure increase in the cylinder above 200 ±20 atm. gauge, the safety device diaphragm is broken and excessive gas mixture is released into the atmosphere. The operating pressure of the cylinder fire-extinguishing mixture is 75 ±5 atm. gauge at a temperature of +15°C. The table below presents pressure in the cylinder versus temperature variations:

t, °C	-45	-35	-25	-15	-5	0	+5	+15	+25	+35	+45
P, kg/cm²	35	40	45	50	55	60	65	70	80	90	100

The cylinder and the piping of the fire-fighting system are painted red.

As was stated above, when the FIRE warning lamp flashes and the fire-fighting equipment is brought into action, the pilot should cut off the engine fuel supply pipeline by depressing SHUT-OFF COCK (ПОЖАРНЫЙ КРАН) button 9 covered with a cap (Fig.73). With the button being pressed for 3 - 4 sec., electro-pneumatic valve 10 operates and supplies air from the aircraft air system into the shut-off cock cylinder, thus stopping fuel supply into the engine.

Chapter IV

TAKE-OFF AND LANDING EQUIPMENT

GENERAL

The take-off and landing equipment of the aircraft includes the tricycle retractable landing gear, wing flaps, three air brakes and a drag chute.

The landing gear consists of one nose and two main struts enabling the aircraft to move on the ground when taking off and landing down.

The flaps of floating type are controlled from the hydraulic system; they are installed on the wing outer surfaces and intended to facilitate taking off and landing. The flap deflection angle is 24°. The flaps are equipped with an electrical position indicating system. For a detailed description of the flaps see Chapter II of this book.

The air brakes are operated by the hydraulic system; two front air brakes and one rear brake are arranged at the fuselage bottom and serve to improve the aircraft manoeuvrability in flight and to reduce speed at landing. The deflection angle of the front air brakes is 25° and that of the rear air brake is 40°. For a detailed description of the air brakes see Chapter II of this book.

The drag chute is located in the fuselage tail section; it is designated to shorten the landing roll. The drag chute is released when the main wheels touch the ground.

I. LANDING GEAR

1. General

The landing gear consists of one nose and two main struts (Fig.75).

The nose strut is mounted in the nose section of the fuselage and retracts forward into the fuselage.

The wing-mounted main struts retract into the wing while their wheels rotating through approx. 87° in relation to the struts, retract into the fuselage.

All the L.G. struts are fitted with the hydro-nitrogen shock-absorber.

The nose strut is equipped with wheel KT-38, its tyre dimensions being 500x180. The main struts are fitted with wheels KT-92, their tyre dimensions being 800x200.

All the L.G. struts are extended and retracted by the hydraulic system, the L.G. air system providing their extension in case of emergency. The L.G. nose strut can be extended on emergency by means of a cable.

In the extended position the nose strut is retained by a hydraulic cylinder with a hydrolock and a mechanical down-lock, while the main struts are kept by cylinders. The latter cylinders have an inner ring lock and a hydrolock locking

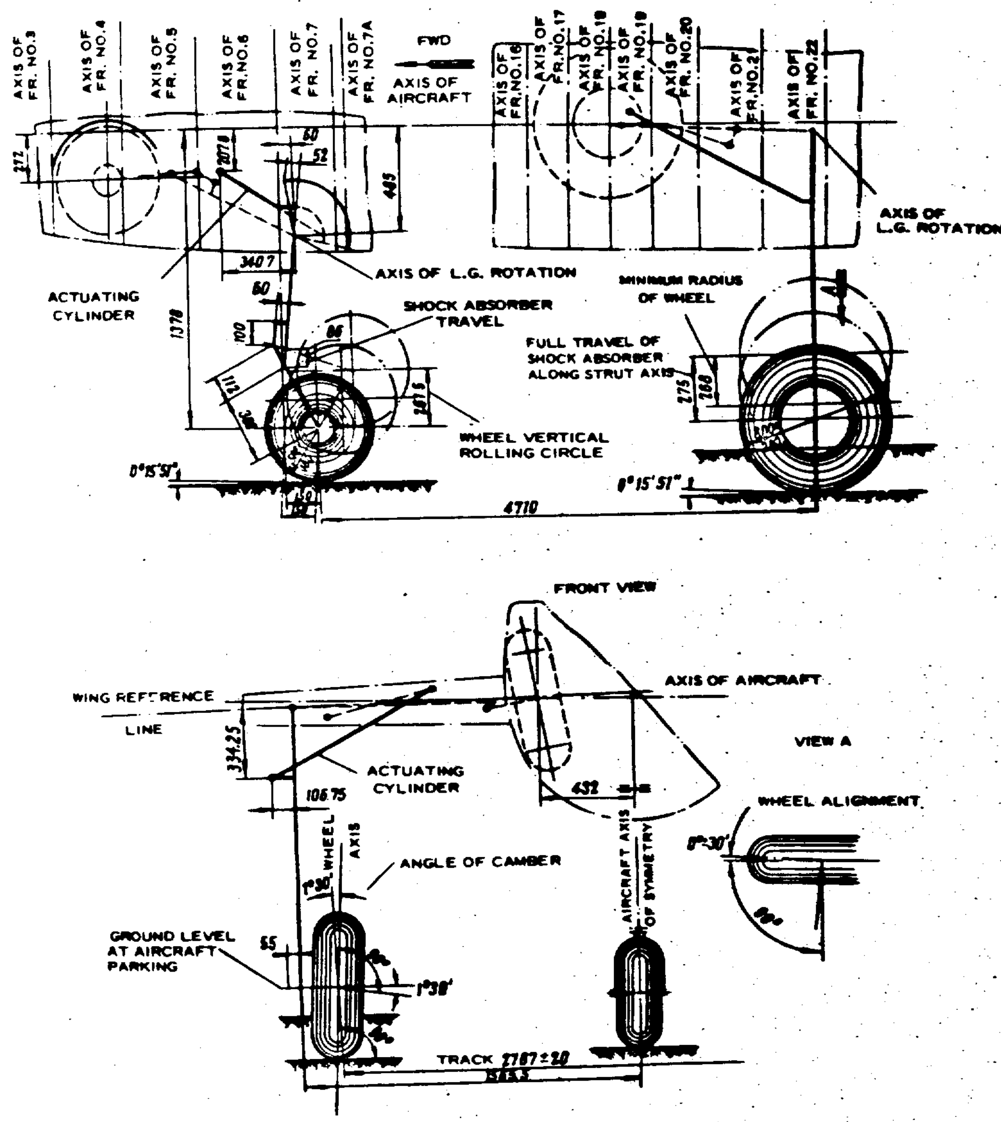

FIG.75. LANDING GEAR GEOMETRICAL DIAGRAM

the hydraulic mixture in the cylinder in the down position. In the retracted position all struts are retained by mechanical up-locks.

The landing gear has the following basic characteristics:

	Main struts	Nose strut
Track	2787 ±20 mm	-
L.G. base	-	4710 ±20 mm
Type and dimensions of wheels	KT-92 800x200B	KT-38 500x180A
Air pressure in tyres	7.5 + 0.5 kg/cm²	7 + 0.5 kg/cm²
Full travel of wheel along strut axis	275 mm	261.5 mm along vertical line
Travel of shock absorber	275 mm	86 mm
Amount of AMT-10 liquid in shock absorber	2400 cm³	650 cm³
Initial pressure of nitrogen in shock absorber	24 ±1 kg/cm²	37 ±1 kg/cm²

2. L.G. Nose Strut

Assembly

The L.G. nose strut is arranged along the aircraft axis of symmetry. It retracts forward in the direction of flight into the fuselage well located between frames Nos 2 and 7a. After the strut has retracted, the well doors are closed by mechanism actuated by the strut.

The L.G. nose strut assembly (Fig.76) includes: L.G. nose strut 1, strut actuating hydraulic cylinder 2, limit switch 3 indicating the strut down position, strut down support 4, control 5 for independent emergency strut extension, limit switch 6 indicating the strut up position, up-lock 7, damper 8, wheel 9, mechanical indicator 10 of the nose strut position, doors actuating mechanism 11, nose strut well doors 12 and lamp 13 indicating the strut down position.

Construction

The nose strut (Fig.77) comprises the following parts: hydro-nitrogen shock absorber, wheel KT-38 with two-chamber air brake, piston-type damper, wheel neutral position cam mechanism used during nose strut retraction, pin mechanism for fixing up and down positions of the nose strut and a cable to ground the aircraft at parking.

The nose strut is considered to be a half-lever type strut.

The load-carrying assembly of the nose strut is made of material 30ХГСНА heat-treated up to 170 ±10 kg/mm² hardness.

The nose strut is composed of the following main load-carrying parts: sleeve 1, shock absorber rod 3 and wheel fork 4.

Sleeve 1 is welded of upper and lower parts. The upper part of the sleeve is a bushing fitted with an arm. The nose strut-to-fuselage attachment axle passes through the bushing. Mounted in the arm is pin 15 fixing the up and down positions of the strut. The arm resting against the front support on frame No.6 takes bending loads at landing, while pin 15, located inside the arm resting against the rear support on frame No.6, takes negative loads.

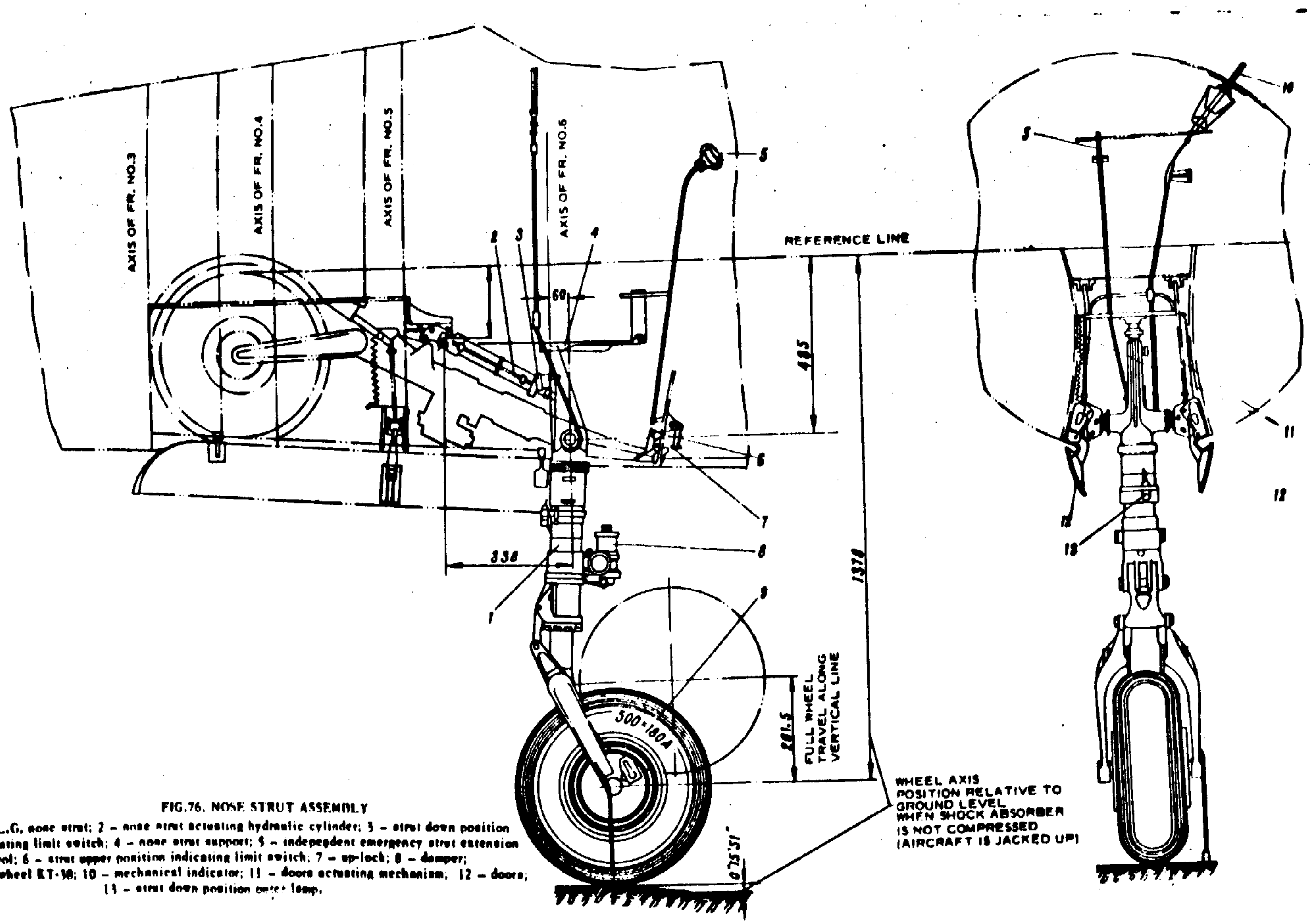

FIG.76. NOSE STRUT ASSEMBLY

1 – L.G. nose strut; 2 – nose strut actuating hydraulic cylinder; 3 – strut down position indicating limit switch; 4 – nose strut support; 5 – indepepdent emergency strut extension control; 6 – strut upper position indicating limit switch; 7 – up-lock; 8 – damper; 9 – wheel KT-38; 10 – mechanical indicator; 11 – doors actuating mechanism; 12 – doors; 13 – strut down position outer lamp.

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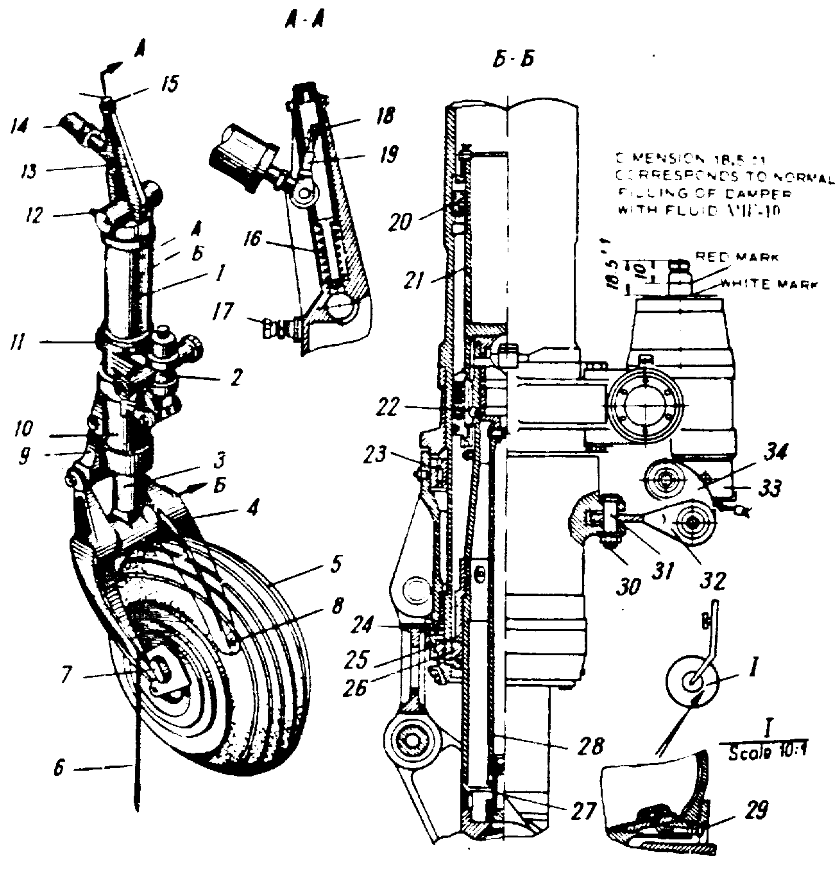

FIG. 77. L.G. NOSE STRUT

1 – upper sleeve; 2 – damper; 3 – rod; 4 – fork; 5 – wheel KT-38; 6 – ground cable; 7 – inertia pick-up УА24 2М-10; 8 – brake connection; 9 – rod; 10 – lower attachment fitting with swivel coupling; 11 – strut down position outer lamp; 12 – lubricant fitting; 13 – bolt connecting link with actuating cylinder; 14 – strut actuating cylinder; 15 – fixing pin; 16 – spring; 17 – shock absorber charging connection; 18 – bolt connecting link with fixing pin; 19 – link; 20 – return stroke valve; 21 – shock absorber plunger; 22 – balls (6 pieces arranged circumferentially); 23 – upper bearing НКБ-1125; 24 – lower bearing НКБ-1126; 25 – rod-mounted cam; 26 – companion cam on sleeve; 27 – rod lock screw; 28 – rod lock guide; 29 – chamber charging connection; 30 – lubricant fitting; 31 – bolt; 32 – bell-crank; 33 – collar; 34 – link.

The pin is connected with the rod of hydraulic cylinder 14. During retraction or extension of the strut the rod first disengages the pin from the corresponding support and then turns the strut. The upper part of the sleeve bears two connections: larger one 17 for the charging valve and the smaller one for checking the level of mixture in the shock absorber.

The lower part of the sleeve is a cylinder carrying swivel coupling 10 connected to the wheel fork. The sleeve mounts stops limiting turning of the coupling within 47° -1° in both directions.

Mounted on the sleeve is a bracket on which damper 2 is fastened by two bolts. The damper is connected to the coupling by a non-linear transmission mechanism consisting of collar 33, link 34 and bell-crank 32.

The inner cavity of the sleeve accommodates the shock absorber.

Shock absorber rod 3 consists of two parts interconnected by a mechanical ball lock. The shock absorber packing and a guide bearing are mounted on the upper part of the rod, while its lower part carries shaped cam 25 of the mechanism for turning the wheel to its neutral position.

Companion shaped cam 26 fixed on the sleeve lower part acts as a second support of the rod.

The shaped cams are arranged so that when the rod is fully released, the wheel assumes the neutral position.

When the shock absorber is compressed, the cams disengage, thus allowing free rotation of the rod. At the end of the rod there is a lug passing the axle for fixing the wheel fork.

Wheel fork 4 is a lever which rotates with respect to the attachment axle when the shock absorber is being compressed. One arm of the wheel fork mounts wheel 5, while the other is linked to swivel coupling 10 through rod 9.

The fork is made of two halves linked to each other by an axle which joins the fork to the rod of the shock absorber.

While taxiing the nose wheel is turned by means of braking the main wheels; the nose wheel rotates on self-aligning bearings 23 (ШКБ-1125) and 24 (ШКБ-1126).

Shock Absorber

The shock absorber (Fig.78) is intended to absorb the work of external forces acting on the wheel during take-off, landing and taxiing.

The shock absorber is of a hydro-nitrogen type. Its operating medium is mixture АМГ-10 and nitrogen. The shock absorber full travel is 86^{+2}_{-1} mm, the initial pressure in the shock absorber being 37 ± 1 kg/cm^2.

The shock absorber consists of cylinder 1 with a brake valve, piston 2 and packing assembly 4.

The load-carrying sleeve of the strut accommodating a valve operating during compression and return strokes is used as cylinder 1. The valve consists of a body, split spring ring 3 and a nut.

Packing assembly 4 of V-shaped rubber and leather cups is installed on the shock absorber rod.

In the upper part of the shock absorber there are two connections: larger one 6 used to fill the absorber with fluid and to charge it with nitrogen and smaller one 5 used for draining excessive mixture АМГ-10 when the absorber is fully compressed after filling. The excessive mixture drained, the connection is closed by a threaded sealing plug.

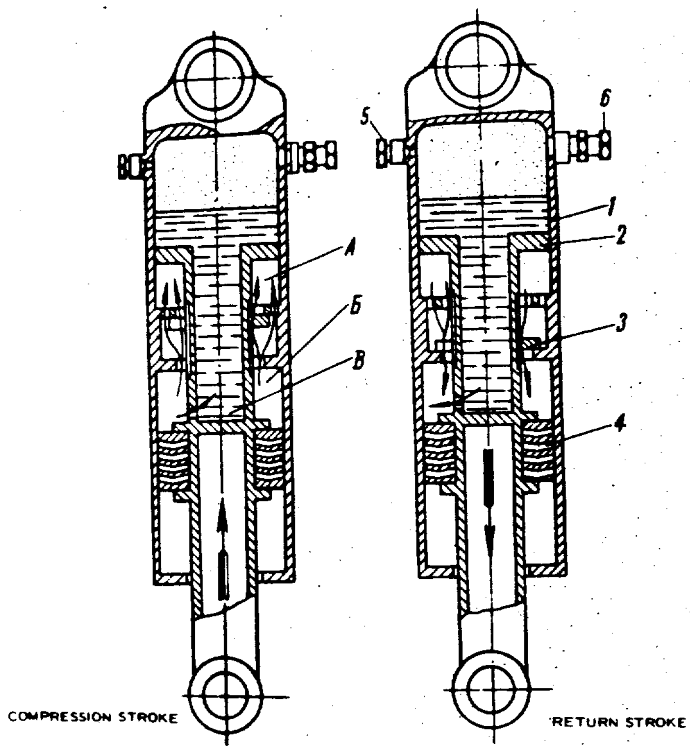

FIG.78. DIAGRAM OF SHOCK ABSORBER OPERATION
1 – cylinder; 2 – piston; 3 – valve split spring ring; 4 – packing assembly; 5 – connection for draining excessive fluid; 6 – connection for filling with fluid and charging with nitrogen.

While compressing the absorber, valve ring 3 acted upon by the fluid pressure, is pressed against the upper fillet of the valve body and the fluid flows from cavity Б into cavities A and B through the piston hole and through the return stroke valve as shown in Fig.78. The pressurized nitrogen in the shock absorber is compressed additionally. At the beginning of the return stroke of the piston under the action of the compressed nitrogen, the valve ring moves downward under the fluid pressure in cavity A and overlaps the clearance between the valve and the piston. In this case the fluid flows from cavity A into cavity Б through the joint in the valve ring, the slotted grooves and the orifice in the piston.

Due to decrease of the area of the orifice through which the fluid flows, the piston speed decreases on its return stroke.

At landing the kinetic energy is absorbed by the shock absorber due to the flow of fluid through the holes in the valve and piston and also due to the compression of nitrogen.

The absorbed energy is dissipated as thermal energy.

Shimmy Damper

The piston-type shimmy damper (Fig.79) is designed to damp sustained shimmies of the wheel arising when the aircraft taxies over the irregularities of the terrain.

The damper is mounted on the nose strut sleeve and its piston with a guide is connected to the swivel coupling through the non-linear transmission mechanism. The non-linear transmission mechanism provides for large piston displacement at small angles of wheel deflection. At large angles of deflection the mechanism provides for small piston displacement.

When the swivel coupling of the nose strut is turned to the right or left along with the fork and wheel, collar 8 through the non-linear transmission mechanism actuates piston 2 enclosed in damper body 6. Piston 2 forcing the fluid filled in the body to flow from one chamber to the other and vice versa through the calibrated orifice A, $1.5A_5$ mm in dia., is braked to interfere with the wheel turning. The rapid movement of the piston is practically impossible and the damper takes up side loads on the wheel gradually damping them.

To allow fluid thermal expansion, a provision is made for an extension piece and orifice Б is made in the piston, 0.4 mm in dia., to connect the right and left operating chambers with the inner one. Extension piece 1 provides for replenishment of mixture in the operating chambers in case of leakage. The damper charging is checked by the position of extension piece rod.

In case the rod goes down to a position where its red mark disappears inside the damper, the latter must be charged up.

Nose Wheel KT-38

Nose wheel KT-38 (Fig.80) with tyre dimensions of 500x180 is of brake type; it ensures the take-off roll, shortens the landing run and allows checking of engine performance at the parking ground without the use of braking chocks.

Basic Specifications of wheel KT-38 (when mounted on aircraft):

Aircraft maximum take-off weight load at parking .... 1310 kg

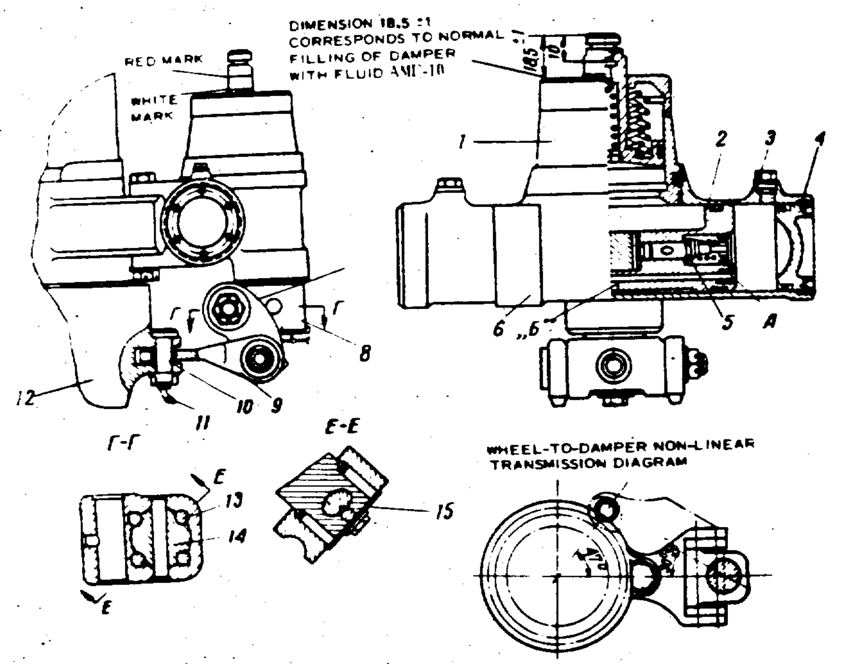

FIG.79. DAMPER

1 – extension piece; 2 – piston; 3 – plug; 4 – cover; 5 – valve; 6 – body; 7 – shackle; 8 – collar; 9 – bell-crank; 10 – bolt, 11 – grease fitting; 12 – coupling; 13 – pin; 14 – guide; 15 – washer.

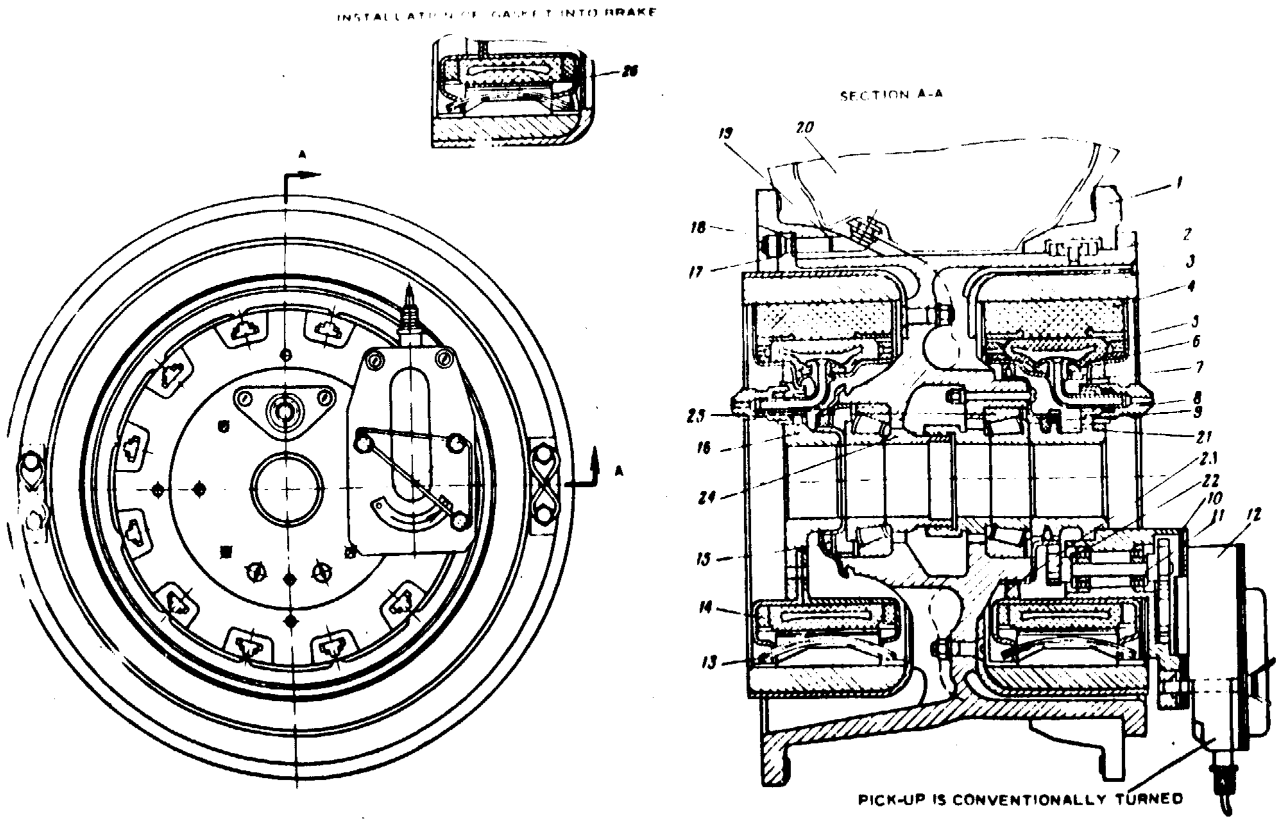

FIG. 80. WHEEL KT-38

1 – removable rim halves; 2 – drum; 3 – jacket; 4 – shoe; 5 – tube; 6 – cup; 7 – valve; 8 – connection; 9 – gland; 10 – bracket; 11 – shaft; 12 – inertia pick-up [illegible]; 13 – return spring; 14 – adjustable ring; 15 – gland; 16 – body; 17 – nut; 18 – cap; 19 – valve; 20 – tyre; 21 – driving gear; 22 – driven gear; 23 – gland; 24 – distance bushing; 25 – roller bearing; 26 – gasket.

Initial operating pressure in tyre	6 ±0.5 kg/cm²
Maximum pressure in brakes	10.5 kg/cm²
Kinetic energy absorbed by wheel during one application of brakes	216,000 kg-m
Landing speed, not over	275 km/hr
Take-off speed	295 km/hr
Weight of wheel	23.8 kg
Weight of assembled wheel	31 kg

Wheel KT-38 consists of drum 2, two brake tubes 5, inertia pick-up 12 and tyre 20.

The drum is a shaped casting of magnesium alloy. Mounted on the drum are: removable rim halves 1 to facilitate tyre mounting, two radial thrust bearings Z and two glands 15 and 9.

Rim halves 1 are interconnected by means of two linings; the tyre mounted, the rim halves are pressed against the drum fillet and are retained from rotation by means of a key.

The outer races of the radial thrust bearings are pressed into specially designed hub recesses; placed between the inner races is distance bushing 24 of adjustable length. On the outer side the bearings are covered with glands 15 and 9 protecting them from contamination and leakage of lubricant.

Attached to the drum butt ends are bimetallic jackets 3 which are centered relative to the axis by the cylindrical grooves at the drum butt ends.

All the brake parts are mounted on body 16. Stamped shaped cups 6 and the body form a trough to accommodate annular rubber-fabric tube 5 and brake shoes 4.

Rings 14 fix tube 5 in the middle position relative to shoes 4 and do not allow the tube to shift aside.

Shoes 4 are of reinforced type (friction plastics is pressed together with metal frame).

Each cup edge has splined projections serving as guides for the shoes. The shoes can travel only in radial direction under the pressure of compressed air supplied to tube 5 through connection 8 and valve 7.

Return springs 13 pass through the holes in the cup splined projections and through the butt-end grooves in the shoes.

Bracket 10 mounting pick-up 12 is secured to the body of one of the wheel brakes. Mounted on the pick-up shaft shank is a gear meshing the gear fixed on the hub body. Shaft 11 carries driven gear 22 which in its turn meshes driving gear 21 fixed on the drum hub.

The gear drive between the drum hub and pick-up is protected from dirt by gland 23.

At braking the compressed air is supplied to the brakes through the pipeline joined to connections 8. Under the pressure of compressed air brake shoes 4 press against jacket 3 and brake the wheel.

When the pressure is being released, the return springs pull the shoes from the jacket and press them to the tube. When the wheel is rotating, the pick-up shaft connected with the wheel through the gear drive is also rotating. When the brake wheel starts skidding, the pick-up sends a pulse to the electromagnetic valve of the brake system, which releases part of pressure from the wheel brakes enabling the wheel to gain speed.

Thus, independently of the pilot the pressure in the brakes varies within the maximum permissible value without causing any wheel skid.

Down-Locks

When extended, the nose strut is fixed by mechanical and hydraulic locks (Fig.81). The mechanical lock is arranged on the rigidity panel under the cockpit floor at frame No.6 and the hydraulic lock is secured in the nose strut well.

The mechanical lock is a rest designed to receive the fixing pin accommodated in the strut arm. On approaching the rest the fixing pin enters the strut arm. In the full down position of the strut the fixing pin acted upon by the spring engages the rest and hinders the reverse travel of the strut.

During L.G. retraction the hydraulic cylinder rod drowns the fixing pin and disengages it from the rest after which the strut freely retracts.

The hydraulic lock operates in case the mechanical lock fails (for the description of the hydraulic lock operation see Chapter V of the present book).

Up-Lock

The nose strut mechanical up-lock is installed in the lower part of frame No.7a (Fig.82).

The up-lock consists of support lever 4, cam 2 and lever 1 fixed on one axle, limit switch 5, springs and welded bracket 6 secured to the frame by bolts.

During retraction the up-lock fixing pin located in the nose strut arm approaches support lever 4, slides along its inclined surface and passes it. At this moment the pin acted upon by the spring moves under support lever 4 which hinders the reverse travel of the strut. Further retraction is limited by the cylinder (the piston rests against the gland cover). In this case the warning lever is pressed away from the limit switch rod by the pin projecting from the nose strut arm, causing the red warning lamp to burn.

During L.G. extension the fixing pin is forced by the hydraulic cylinder rod to sink down and go from under the up-lock support lever. Cam 2 retains the support lever from rotation, the up-lock parts being immovable.

When the nose strut is being extended independently on emergency by cable 8, lever 1 turns together with cam 2 and releases the support lever which turns, under the strut weight and the strut goes out of the well. In this case the fixing pin does not go into the strut arm.

During strut extension lever 7 is released and under the action of the spring turns and presses on the limit switch rod. At this moment the strut retraction warning lamp goes out.

Nose Strut Doors

The nose strut doors (Fig.83) close the well in the fuselage when the strut is retracted. They consist of two symmetrical parts; each of the parts is hinged to two brackets and has a mechanism for actuating the doors.

The actuating mechanism of each door includes rod 4, universal rod 3 and actuating arm 2. The actuating arms are interconnected through pipe 7.

During nose strut retraction the wheel fork presses pipe 7 and the doors are closed through rods 4 and 3 and cranks 9.

During nose strut extension the wheel fork moves off the pipe and the rods with the crank, acted upon by springs 1, open the doors.

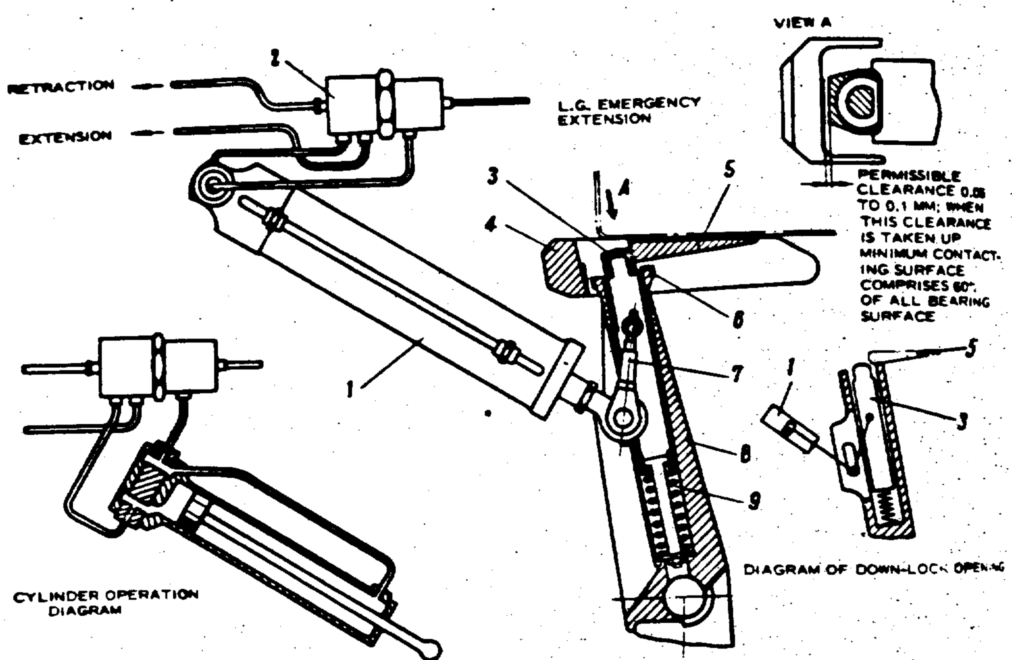

FIG.81. DOWN-LOCKS

1 – hydraulic cylinder; 2 – hydraulic lock; 3 – pin of nose strut arm; 4 – front rest; 5 – rear rest; 6 – supporting ring; 7 – link; 8 – nose strut arm; 9 – spring.

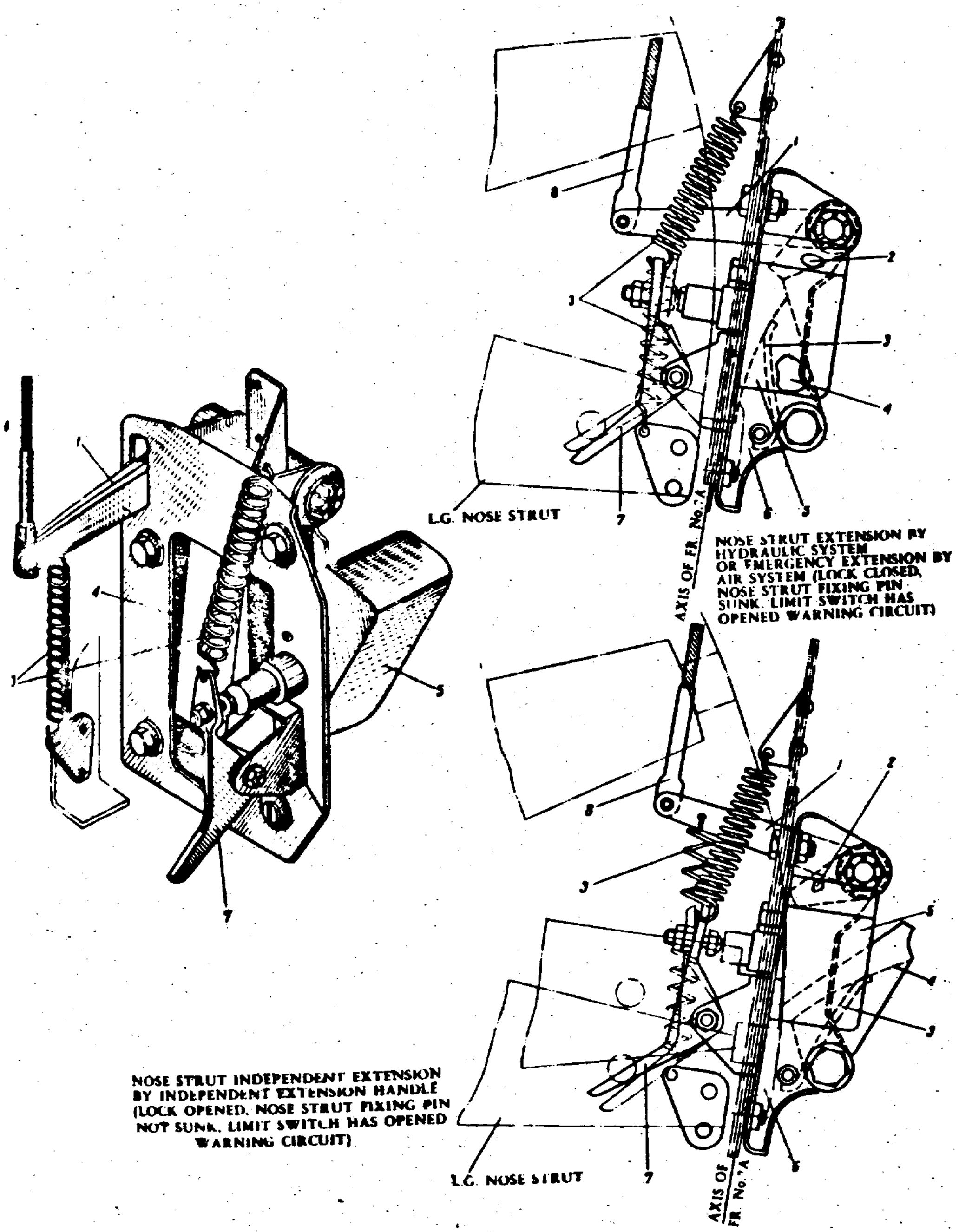

FIG. 82 - UP-LOCK
1 - lever; 2 - cam; 3 - springs; 4 - support lever; 5 - limit switch BK-2-140P; 6 - bracket; 7 - warning system lever; 8 - cable from independent extension handle

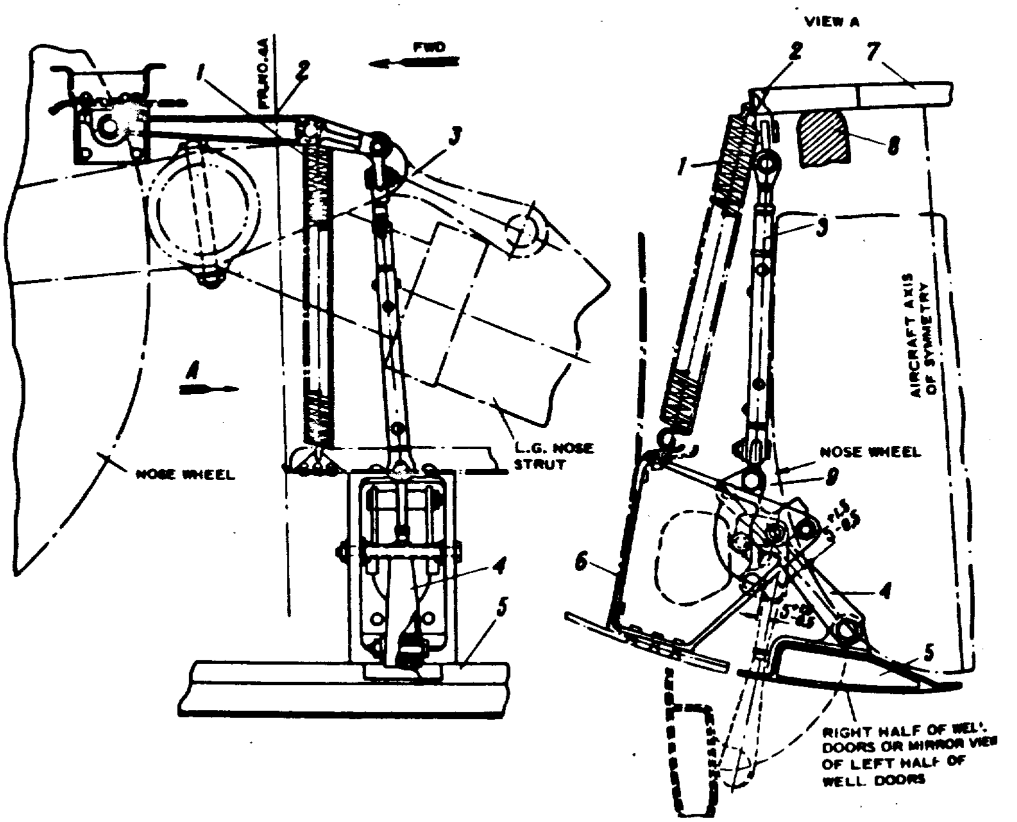

FIG.83. NOSE STRUT WELL DOORS

1 – spring; 2 – actuating arm; 3 – universal rod; 4 – rod; 5 – well door; 6 – bracket fastening rod to door; 7 – pipe; 8 – fork; 9 – link;

Nose Strut Retraction and Extension

The nose strut is retracted and extended in the following way:

When the landing gear control is shifted to the UP (УБРАНО) position, electromagnetic valve ГА-142/1 connects the L.G. retraction line with the pressure line and the L.G. extension line with the vent line. The hydraulic mixture reaches the hydraulic lock, opens it and then enters the L.G. actuating cylinder, the cavity for the retraction.

While moving, the hydraulic cylinder rod first disengages the fixing pin in the strut arm from the rest and then turns the strut in the retracted position.

At the moment the strut has almost retracted, the fixing pin slides along the inclined surface of the lock set on frame No.7A, sinks inside the strut arm, leaves the lock surface and fixes the up position of the strut. At the same moment the well doors close.

When the landing gear control is shifted to the DOWN (ВЫПУЩЕНО) position, the valve connects the L.G. extension line with the pressure line and the L.G. retraction line with the vent line. The mixture is pressed into the hydraulic cylinder to retract the strut and begins removing the rod.

The pin is drawn into the strut arm and comes out of engagement with the up-lock support lever after which the strut starts extending. Simultaneously the well doors start opening. Acted upon by the spring, the rod takes the initial position.

When the strut assumes the vertical position, the fixing pin slides over the inclined surface of the rear rest installed under the cockpit floor, sinks into the strut arm and, by-passing the rear rest, takes the initial position under the action of the spring. After this the nose strut is fixed in the down position.

Nose Strut Emergency Extension. The emergency extension of the nose strut is performed together with the L.G. main struts by the air system.

The L.G. handwheel cock is set in position DOWN and the L.G. emergency extension cock is opened.

The air enters the hydraulic cylinder, removes the rod which disengages the fixing pin from the up-lock support lever and the strut is extended.

Nose Strut Independent Extension System. The nose strut independent extension system (Fig.84) makes it possible to open the up-lock by means of a cable in case of emergency.

From the up-lock the cable passes into the cockpit where it terminates in a handle brought out onto the lower part of the instrument board. During independent extension of the nose strut the L.G. cock is set into position NEUTRAL (НЕЙТРАЛЬНО) and the handle is pulled backward.

When pulling the handle the up-lock opens and the strut leaves the fuselage by gravity and then is extended to its full length by the ram air.

The independent emergency extension of the strut is resorted to only when the strut fails to extend for some reason or other or in case of emergency landing with the main struts retracted.

Warning System

The nose strut is equipped with mechanical and light warning systems which indicate the up and down positions of the strut (Fig.85).

The mechanical indicator is essentially a pin arranged in the upper part of the fuselage at frame No.6 on the left-hand side and connected with the strut by

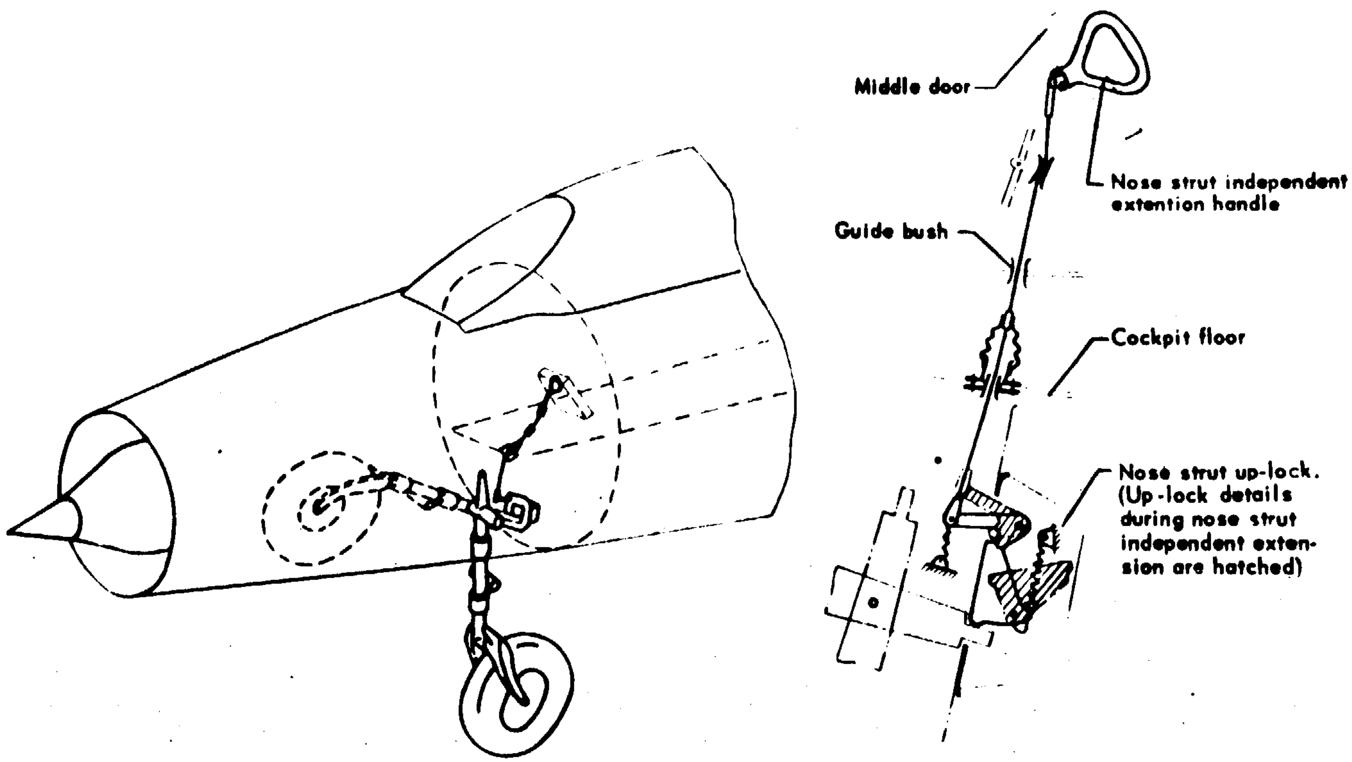

FIG.84. DIAGRAM OF NOSE STRUT INDEPENDENT EXTENSION

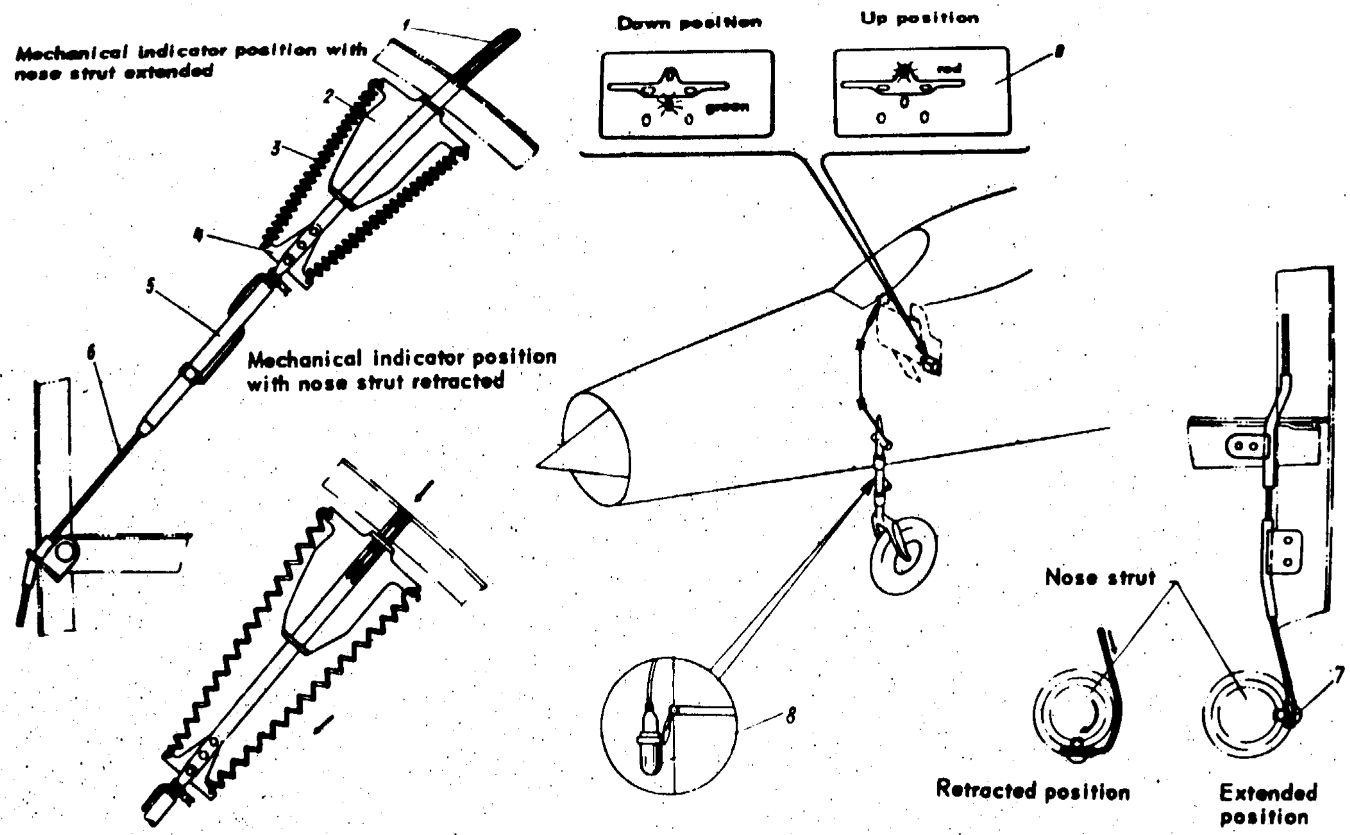

FIG.85. NOSE STRUT POSITION WARNING SYSTEM
1 – mechanical indicator-pin; 2 – fixed bracket; 3 – spring; 4 – bracket;
5 – adjusting turnbuckle; 6 – cable; 7 – bolt securing cable to strut;
8 – L.G. position outer indicating lamp; 9 – panel ППС-2.

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a cable. During strut extension the pin juts out 50 mm over the skin, acted upon by the springs. During strut retraction the cable is wound on the strut sleeve and the pin is drawn into the fuselage. On strut retraction the pin sets flush with the skin.

The up and down positions of the L.G. nose strut are indicated by the green and red lamps which light up on warning panel ППС-2. Panel ППС-2 is installed in the pilot's cockpit on the left-hand stationary part of the instrument board. The lamps are switched on and off by means of limit switches installed in the fuselage recess on frame No.6 at the left-hand side, to indicate the down position of the strut, and on the nose strut suspension lock, to indicate the up position of the strut.

When the nose strut is extended, the pin projecting from the strut arm presses one lever of the bell crank. The other lever moves away from the down position limit switch rod and a green lamp lights up on warning panel ППС-2 signalling the extension of the strut. During the retraction of the nose strut the bell crank, acted upon by the spring, presses the rod of the limit switch and the green lamp goes out.

In the up position of the nose strut the warning lever arranged on the nose strut suspension lock is pressed away from the limit switch by the pin projecting from the strut arm. In this case the red lamp burns. During extension the warning lever gets released and, acted upon by the spring, presses the limit switch rod, and the red lamp goes out.

Besides, the nose strut mounts an electric lamp of the external warning system to indicate the strut down position; it is used to check the strut position from the ground during night flights.

3. L.G. Main Struts

Arrangement

The L.G. main struts (Fig.86), when retracted, are arranged under the wing.

During retraction the main struts are drawn into the wing, whereas the wheels turn relative to the struts by approx. 87° and retract into the fuselage wells located between frames Nos 16 and 20. Each L.G. main strut is secured to the wing by means of removable rotation axle 9 which is mounted on bearings of the front spar and the main beam.

The strut actuating hydraulic cylinders serve as a load-carrying bracke strut taking landing loads and transmitting them to the wing structure. The hydraulic cylinder is attached to the wing by load-carrying fitting arranged on the wing front spar and to the strut by a swivel bolt of the brace strut.

Construction

The main L.G. strut (Fig.87) is equipped with: hydronitrogen shock absorber, wheel KT-92, wheel turning mechanism, strut door, crosspiece board and lamp of the external warning system.

The main strut of a cantilever type includes the following basic parts: sleeve, rod, axle shaft and torque arms.

The load-carrying parts of the strut are made of material 30ХГСНА heat-treated up to 170 kg/cm^2.

The sleeve is the main load-carrying element imparting loads from the wheel to the wing structure. It consists of the upper and lower attachment units welded to each other.

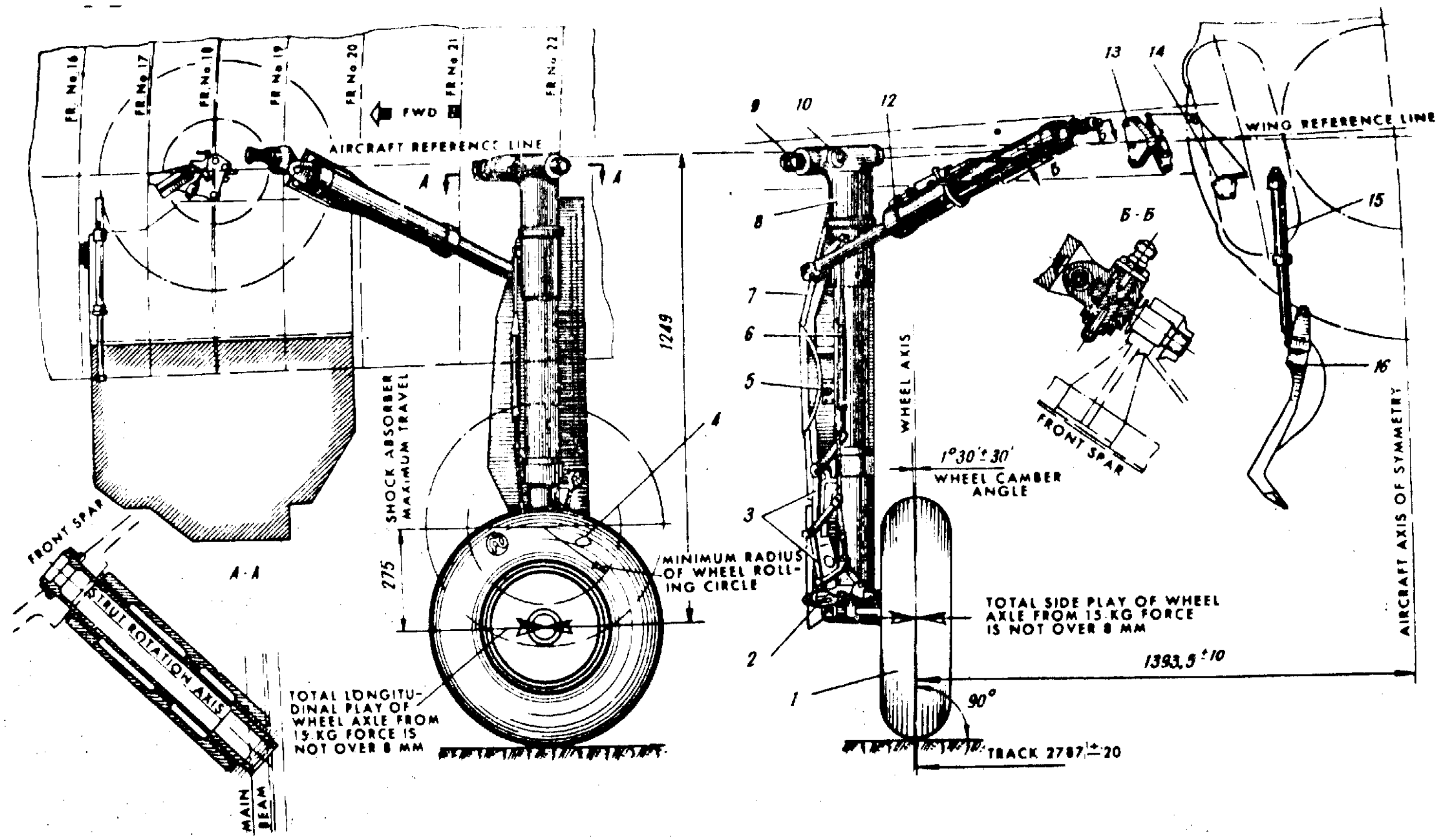


FIG. 86 LANDING GEAR MAIN STRUTS

1 - wheel KT-92; 2 - yoke for securing L.G. strut on up-lock; 3 - wheel turn parallelogram linkage mechanism; 4 - cross piece shield; 5 - L.G. position outer indicating lamp; 6 - wheel turning mechanism rod; 7 - shield on main strut; 8 - L.G. main strut; 9 - main strut rotation axle; 10 - L.G. down position warning system limit switch; 11 - L.G. up position warning system limit switch; 12 - L.G. strut actuating hydraulic cylinder; 13 - main strut up-lock; 14 - door lock; 15 - door actuating hydraulic cylinder; 16 - wheel door.

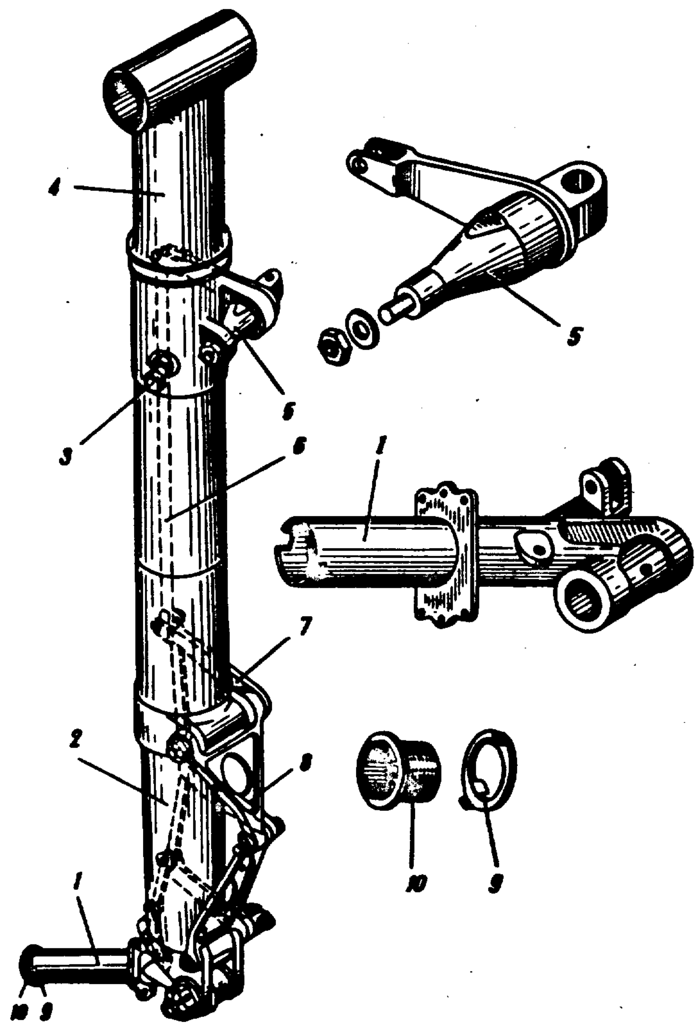


FIG.87. L.G. MAIN STRUT CONSTURCTION
1 – wheel axle shaft; 2 – rod; 3 – charging valve; 4 – sleeve; 5 – bolt with bell-crank; 6 – wheel turning mechanism rod; 7 – wheel turning mechanism bell-crank; 8 – torque arms; 9 – washer; 10 – nut.

The upper attachment unit has two bushings for the L.G. rotation axle; the inner cavity of this attachment unit has an outlet connection and is used as a 2.23 lit. bottle for the air compressed to 110-130 kg/cm^2.

Inside the lower attachment unit there is a stiffening wall which serves as a bottom of the air bottle. The shock absorber plunger is secured to the other side of the wall.

The sleeve is an outer tube of the shock absorber. Fastened to the sleeve are a hydraulic cylinder (by means of a brace bolt), a charging connection, the lug for towing the aircraft and for its anchoring during ground racing of the engine, the upper crosspiece and the strut door.

The rod consists of two parts interconnected by welding. The upper part of the rod is a thick-wall tube with a bottom in the middle and with a threaded upper part to receive the upper bearing and the return stroke valve. The stamped lower part of the rod terminates in a plug and has a wheel turning mechanism. Fastened to the lower part of the rod is the axle shaft and the lower crosspiece of the torque arm. The bottom of the lower part of the rod serves as a bearing element to which loads are imparted from the axle shaft at landing.

The strut rod has two supports on the sleeve: the upper and lower bearings, therefore the rod operates as a beam on two supports taking stresses resulting from compression and bending.

The axle shaft has a flange to secure the wheel brake and a link for attaching to the rod. The axle shaft is also provided with a cantilever fork which mounts a kinematic lock element for fixing the axle shaft in the extended and retracted positions.

There is a removable rest on the axle shaft to transmit loads from the axle shaft to the rod.

The torque arms of the strut serve to impart the torque moment from the rod to the sleeve and consist of the stamped upper and lower crosspieces.

The upper crosspiece is attached to the lower sleeve by a special bolt which also serves as an axle of the turning mechanism bell-crank. The upper crosspiece has three holes to secure the door closing the wing cut-out for the strut.

The lower crosspiece is joined to the rod by an axle to which a yoke is fastened for holding the strut by the up-lock.

Shock Absorber

The hydronitrogen shock absorber of the main strut (Fig.88) is of a plunger type providing for retarding movement of the strut during compression and return strokes. The shock absorber is arranged inside the strut sleeve.

At landing the shock absorber and the pneumatic tyre of the wheel decreases the shock imparted to the wheel and wing, makes the shock action increase and decrease smoothly and thus protects the L.G. strut and the wing framework from breaking.

The maximum travel of the shock absorber at compression is 275 mm. The shock absorber is filled with 2400 cm^3 of mixture АМГ-10 and with nitrogen at a pressure of 24 $\pm$1 kg/cm^2.

On one side shock absorber plunger 2 is provided with a ball support on which it is attached to the wall of the sleeve lower attachment unit, while on the other side it is provided with a bottom having an orifice through which the fluid is forced during the compression stroke of the shock absorber.

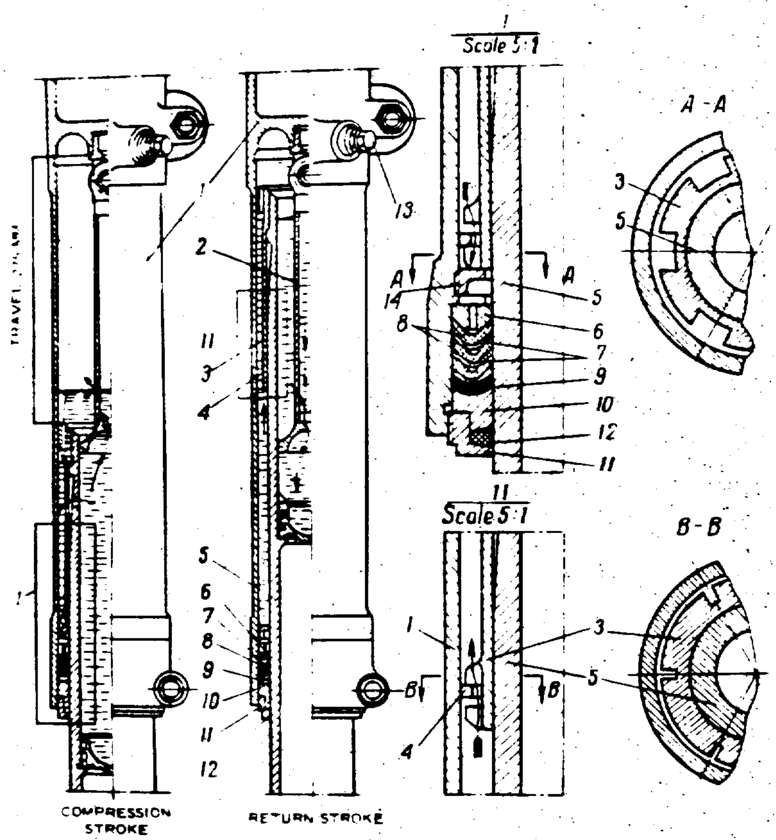


FIG 88. SHOCK ABSORBER OPERATION DIAGRAM

1 – sleeve; 2 – plunger; 3 – upper bearing; 4 – reverse braking valve ring; 5 – rod; 6 – support ring; 7 – duralumin ring; 8 – rubber cup; 9 – leather cup; 10 – lower bearing; 11 – nut; 12 – gland; 13 – charging connection; 14 – nut.

The bottom has a cylindrical groove to insert an iron expansion ring. Rod 5 slides with its inner surface over the ring during the compression stroke.

The rod is centered on two bronze bearings: upper 3 and lower 10. The upper bearing is thread-mounted on the rod and is provided with orifices arranged along the ring to provide for fluid flow. The lower bearing is centered by its outer diameter on the sleeve inner diameter and by means of nut 8 tightens the packing assembly consisting of rubber, duralumin and one leather cups.

The shock absorber operates as follows. During compression stroke the fluid trapped in the inner space of rod 5 and limited by the bottom of plunger 2 is forced through the orifices in the plunger bottom and walls and through the holes in the rod and upper bearing 3 (in the rod at stroke h = 40 mm only) into the return stroke chamber formed by an assembly of V-shaped packings, a return stroke valve and by the walls of the sleeve and the rod. In this case the iron resilient ring in the return stroke valve is pressed away by the fluid from the return stroke valve seat and provides free flow of the fluid into the return stroke chamber.

During return stroke the rod forced by the compressed nitrogen starts moving and displaces the fluid from the return stroke chamber. At the same time the iron resilient ring presses against the seat of the return stroke valve, lessens the passage area for fluid flow and thus retards the movement of the strut.

During compression stroke the fluid passing through the hole in the plunger bottom and through the hole in the rod, is retarded too, but to a lesser degree than during the return stroke.

Main Wheels KT-92

Wheel KT-92 with the 800x200B tyre is equipped with a universal rim for an aircraft high-pressure tyre (tube and tubeless); the wheel is fitted with a disc brake and inertia pick-up and is intended to ensure proper take-off and landing runs and taxiing of the aircraft.

Wheel KT-92 has the following basic characteristics (when mounted on the aircraft):

Maximum aircraft take-off load on the wheel at standstill .... 3950 kg
Maximum aircraft landing load on the wheel at standstill .... 2820 kg
Tyre pressure at rated take-off weight .... 7.5 +0.5 kg/cm^2
Brake operating pressure .... 19 +2 kg/cm^2
Kinetic energy absorbed by wheel during one application of brake .... 490,000 kg-m
Aircraft landing speed, not over .... 300 km/hr
Aircraft take-off speed, not over .... 325 km/hr
Wheel weight (without tyre) .... 60 +1 kg
Aircraft speed at which brakes are applied .... 245 km/hr

The wheel (Fig.89) consists of drum 1, disc brake 2, inertia pick-up 10 and tyre 28.

Drum 1 is a shaped casting of magnesium alloy. It mounts removable rim halves 27, two radial thrust bearings 8 and gland 9.

Rim halves 27 are made solid. On the drum they are held from rotation by two pins 23 and from sliding they are kept by two semirings 24. Pressed into the drum hub are outer races of radial thrust bearings 8. From the outside the bearings are protected with a gland and cover. Placed between the bearings is a adjustable bushing.

The wheel embodies disc brake 2 consisting of body 6, cylinder unit 3, bimetallic sector discs 22, three metal powder discs 29, pressure disc 16, pistons 18 with packing rings, twelve tubes 17 with packing rings, three sectors 5, cover 4, eight clearance adjusters 13 and connection 30 for joining to the brake control system.

The bimetallic discs are made of individual sectors joined to each other in pairs on a steel ring. Each bimetallic sector is a frame of sheet steel lined on one side with special iron to form a friction surface. The discs can shift along their axes in the guides in the brake body.

The three metal powder discs consist of the steel frame, blind hollow washer and twenty-four sectors with metal powder ФМК-11 baked to them. The sectors are riveted in pairs and can shift relative to the body. The metal powder discs and bimetallic discs form friction pairs.

The pressure disc consists of a steel disc and bimetallic sectors riveted to it, the bimetallic sectors forming the friction surface.

The cylinder unit is cast of aluminum alloy in the shape of a disc and comprises twelve cylinder sockets to receive tubes. The cylinder cavities are interconnected through an annular duct located in the cylinder unit. The cylinder unit is set on the straight portion of the brake body. The three stop sectors forming the locking ring keep the cylinder unit from slippage off the body.

The piston is a hollow sleeve with a spherical bottom and a plunger mounted inside it. The piston is inserted into the tube before the latter is screwed into the cylinder body.

The clearance adjuster consists of a rod, nut, return spring, clamp and stop. The clearance adjusters are located in special recesses in the cylinder unit and are protected with covers. The rods are attached to the pressure disc by means of nuts. Fitted onto the rod is a clamp adjusted to a shift force of 70 ± 5 kg.

When the pressure is fed into the cylinders, the pistons act on the pressure disc which moves in the axial direction and, overcoming resistance of the return springs of the clearance adjusters, compresses the pack of discs. During wheel rotation a friction moment will be created on the friction surface of the discs and the wheel will get braked.

When pressure is released from the cylinders, the return springs press the disc in the opposite direction and the wheel becomes released. In this case the total clearance between the discs (which changes due to wear) is automatically adjusted within the limits from 2 to 4 mm by the clearance adjusters.

The inertia pick-up is attached to the brake body. The pick-up gear meshes the gear which is secured on the drum hub. If the braking moment of the brake exceeds the wheel torque moment (the wheel begins skidding), the pick-up sends a pulse to the electromagnetic unit of the brake system which releases some pressure from the brake cylinders.

Thus, in the course of braking the pressure in the brake is kept within the maximum permissible value which does not cause any skidding effect.

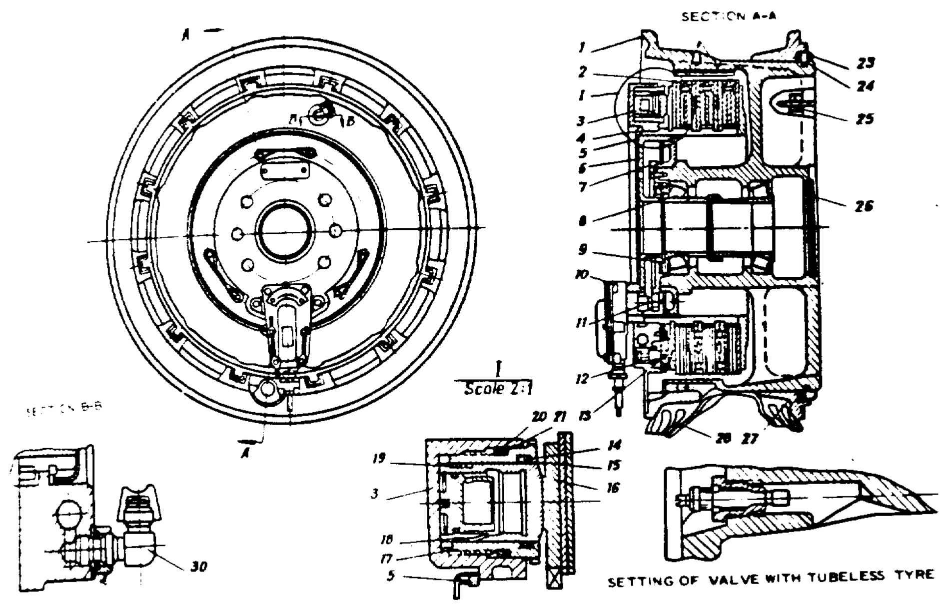
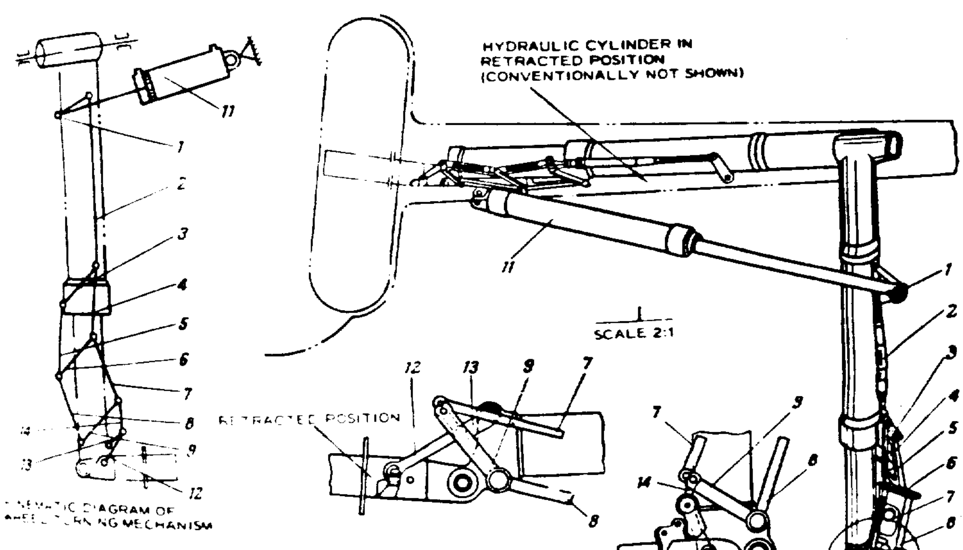


FIG.89. WHEEL KT-92

1 – drum, 2 – disc brake; 3 – cylinder unit; 4 – cover; 5 – stop sector; 6 – body; 7 – gear, 8 – radial-thrust bearing, 9 – gland, 10 – inertia pick-up YA-23/2M-13 (right) and YA-23/2M-14 (left); 11 – pick-up gear; 12 – return spring; 13 – clearance adjuster; 14 – packing ring; 15 – protective washer; 16 – pressure disc; 17 – tube; 18 – piston; 19 – protective ring; 20 – packing ring; 21 – packing washer; 22 – bimetallic discs; 23 – rim fastening pin; 24 – half-ring; 25 – balancing plate; 26 – cover; 27 – rim; 28 – tyre; 29 – metal powder discs; 30 – angle-piece.



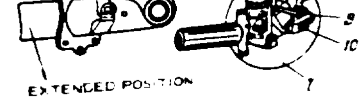


FIG.90. WHEEL TURNING MECHANISM

1 – hinge joint of hydraulic cylinder rod; 2 – rod; 3 – bell-crank; 4 – rod; 5 – upper crosspiece; 6 – bell-crank; 7 – rod; 8 – lower crosspiece; 9 – bell-crank; 10 – yoke; 11 – hydraulic cylinder; 12 and 13 – kinematic lock rods; 14 – link.

Wheel Turning Mechanism

The mechanism for turning the main strut wheel (Fig.90) is an assembly of rods and bell-cranks linked by rod 2 with a lever-type bolt fixing the stem of hydraulic cylinder 11.

The mechanism turns the wheel axle shaft at an angle of approx. 87° with respect to the strut during retraction of the wheel into the fuselage.

The wheel turning mechanism consists of rod 2, a parallelogram linkage system providing the turning mechanism operation independently of the strut shock absorber compression and a kinematic lock which locks the wheel axle shaft in the up and down positions of the wheel.

Adjustable rod 2 is attached with its upper end to the arm of the lever-type bolt, while with its lower end, it is attached to bell-crank 3 of the parallelogram linkage system.

The parallelogram linkage system includes three parallel bell-cranks 3, 6, 9 and two rods 4 and 7 which are parallel to the crosspieces of the torque arm forming two parallelograms.

The kinematic lock of the turning mechanism includes split member 13 resting with its cantilever part against the lug of the stem and rod 12 connecting the wheel fork with the split member.

The kinematic pair is selected so that when the wheel axle shaft is in the down or up position the axes of the split member and rod are arranged along a line passing through the split member rotation axis. The zero arm provides locking of the axle shaft in two extreme positions (extended and retracted) relative to the split member rotation axis. Fastened to the common point of the split member and the rod of the kinematic lock is a link which shifts the kinematic lock from the zero position. This link is connected with its other end to bell-crank 9 mounted on the lower crosspiece axle.

As the landing gear moves up and down the hydraulic cylinder turns the hydraulic cylinder fastening bolt. During rotation of the arm which is made integral with the bolt the adjustable rod moves and shifts the bell-crank which via rods 4 and 7 imparts motion to bell-crank 9. The latter bell-crank pushes the link opening the kinematic lock and shifting rod 12 and through the latter the shaft axle of the wheel.

The wheel turning mechanism is adjusted by changing the length of the adjustable rod till the kinematic lock pairs axes are aligned.

In the down position the lock is checked for proper closing by a feeler gauge (which is a wire, 3 mm in diameter).

If the kinematic lock is closed, the gauge should go through the holes in the rod and the lock split member.

Main Strut Hydraulic Cylinder.

Down-Locks

The main strut hydraulic cylinder is intended for retraction and extension of the main strut. In the down position the hydraulic cylinder serves as a load-carrying brace. In this position the hydraulic cylinder holds the strut by means of a mechanical lock arranged inside the hydraulic cylinder. Mounted on the hydraulic cylinder is a distributing box.

The hydraulic mixture is delivered into the cylinder through the distributing box; in case of L.G. emergency extension it is air that is delivered into the cylinder. The box housing encloses the hydraulic one-way down-lock, an emergency valve and a thermovalve.

The hydraulic lock (its operation is described in Chapter V of this book) operates in case the mechanical lock fails to close.

The emergency air valve is connected with the hydraulic cylinder extension cavity and serves to supply air into the hydraulic cylinder during emergency extension of the landing gear.

The thermovalve is calibrated for the pressure of 275^{+15} kg/cm^2 and serves to release high pressure from the closed interior of the hydraulic cylinder at great temperature changes.

The mechanical lock (Fig.91) is arranged in the piston of the hydraulic cylinder rod and includes split spring ring 1 and lock bushing 4 with spring 5. When rod 3 moves during extension and in the retracted position the split ring is compressed, the lock bushing is pressed and the spring is loaded.

When the L.G. control is set in the DOWN position, the hydraulic mixture is routed through the swivel union into the distributing box and from there into the extension cavity of the L.G. hydraulic cylinder shift the rod with the mechanical lock. The mechanical lock is centered on the tapered surface of the lock bushing. At the moment the rod reaches the extreme extended position, split spring ring 1 comes up to seat A, is released and made to enter the seat.

In this position the split spring ring is fixed by the lock bushing. Acted upon by the spring, the outer diameter of the bushing enters the inner diameter of the split spring ring, thus preventing its compression. The lock is closed, and due to the axial load during retraction the rod cannot shift as it bears against the fixed split spring ring with its protrusion.

When the L.G. control is shifted in the UP position,the hydraulic mixture enters the hydraulic cylinder retraction cavity and shifts the lock bushing, releasing the split spring ring. The compressed hydraulic cylinder shifts the rod for retraction, moves the split spring ring which gets compressed along the tapered ends of the groove on the body to the size of the cylinder diameter; as a result, the strut is retracted.

Up-Lock

The main struts are retained in the UP position by the mechanical locks mounted in the wing wells for the main struts.

Each lock (Fig.92) consists of hook 2 with spring, cam 3, lever 6 and cylinder 9 used for removing the struts from the locks and consisting of the main (hydraulic) and emergency (air) cylinders.

When the L.G. is extended by means of the hydraulic system, the operating fluid enters the lock hydraulic cylinder.

Lock cylinder rod 7 extends and turns lever 6 and cam 3 mounted on the same axle. The cam turns and releases hook 2. The hook acted upon by the spring and strut weight, turns and releases the strut suspension yoke. When the up-lock lever turns, the main wheel doors lock gets opened. The latter lock is connected with the up-lock of the landing gear main strut by means of a cable.

During emergency L.G. extension the air enters the up-lock air cylinder, extends the rod of air cylinder 5 which turns lever 6 with cam 3. The lock then operates in the same manner as when the struts are extended from the hydraulic system.

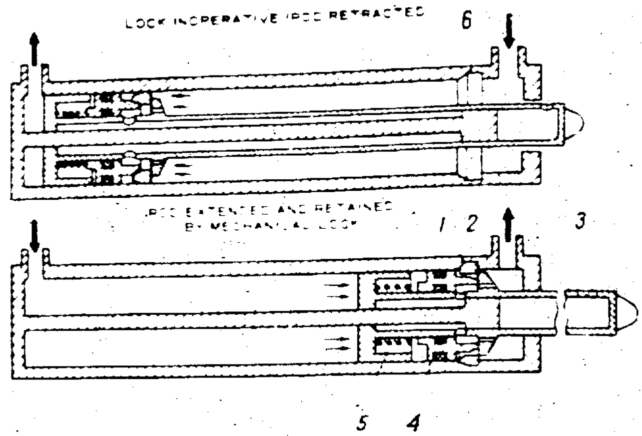


FIG. [illegible] DIAGRAM OF HYDRAULIC CYLINDER LOCK OPERATION
1 – spring split ring, 2 – cylinder, 3 – rod, 4 – lock bushing; 5 – spring, 6 – lock seat.

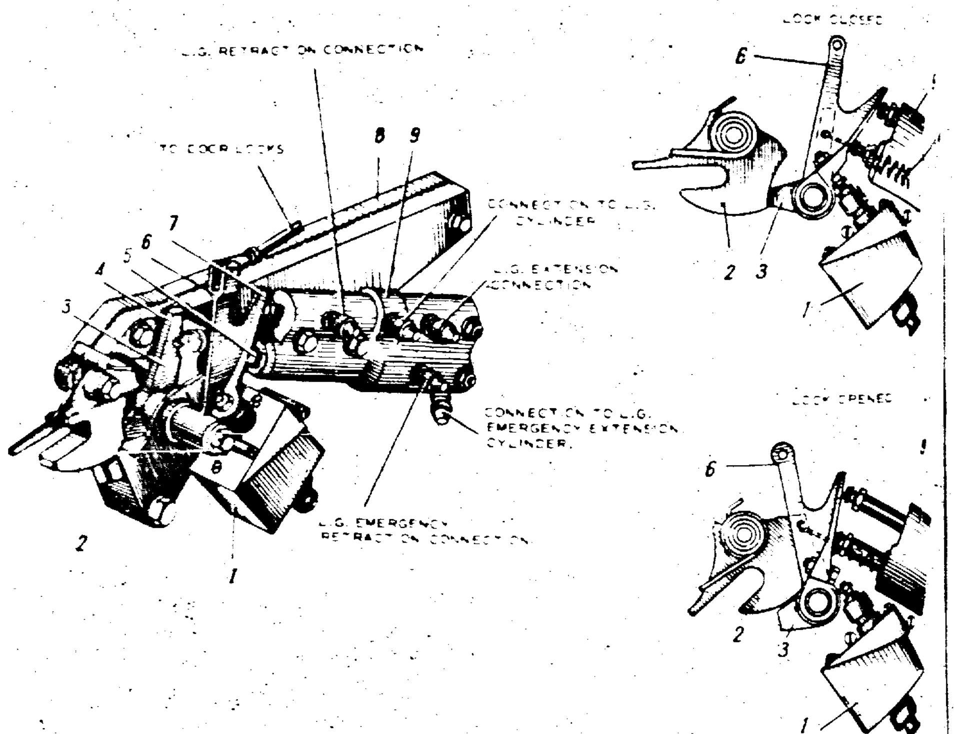


FIG.82. UP-LOCK
1 – limit switch BK-2-200P, 2 – hook with spring, 3 – cam, 4 – spring, 5 – emergency air cylinder rod, 6 – lever
7 – hydraulic cylinder rod, 8 – lock body, 9 – unlocking cylinder.

SECRET

During strut retraction the lock is closed as follows: the strut yoke slides along the hook lobe and rotates the hook until the cam comes into the hook shaped cut-out; as a result, the hook gets fixed.

Limit switch 1 located on the up-lock body is designed to indicate the closed position of the lock.

L.G. Main Strut Doors

The L.G. main strut doors (Fig.93) include a wheel door, a strut door and a crosspiece door.

The wheel door closes the cut-out in the fuselage for the wheel and is hinged to the fuselage longeron by means of two attachment units The door is opened and closed by a special hydraulic cylinder with a ball down-lock. In the up position the wheel door is closed by the lock which is connected with the L.G. main strut lock by means of a cable and opens a little bit before the main strut lock opens.

The strut door and the crosspiece door close the cut-out in the wing for the strut. The riveted strut door is rigidly connected to the main strut sleeve The strut door has an insert which is disconnected from the door when the external load is mounted on aircraft.

The stamped crosspiece door is rigidly connected to the upper crosspiece of the torque arms by means of three screws.

L.G. Main Strut Retraction and Extension

The L.G. main strut is retracted and extended in the following way.

When the L.G. control is shifted to the UP position, electromagnetic valve ГА-142/1 connects the L.G. retraction line with the pressure line and the L.G. extension line with the vent line.

The pressed hydraulic mixture passes the hydraulic cylinder of the up-lock and, displacing the rod, reaches the distributing box and opens the hydraulic lock.

In this case the hydraulic mixture enters the retraction cavity of the main strut extension and retraction cylinder. The mechanical lock opens and the rod freely retracts turning the bolt and lever and actuating the wheel turning mechanism.

The moment the strut has almost retracted, the strut yoke slides along the hook lobe and begins to turn the hook till the cam is against the hook cut-out which it enters under the action of the spring. As a result the hook is fixed and holds the strut in this position.

In the up position the strut presses against the lever of the sequence valve and the hydraulic mixture enters the retraction cavity of the door actuating hydraulic cylinder. The door closes and gets locked.

When the L.G. control is shifted to the DOWN (ВЫПУЩЕНО) position,the valve connects the L.G. extension line with the pressure line and the retraction line with the vent line.

The pressurized hydraulic mixture is delivered to the strut suspension lock hydraulic cylinder and shifts the rod. In its movement the rod pushes the cam lever, opens first the wheel door lock by means of the cable and then the strut lock.

After this the hydraulic mixture is fed to the hydraulic cylinder of the wheel door and, passing through the distributing box, approaches the strut actuating

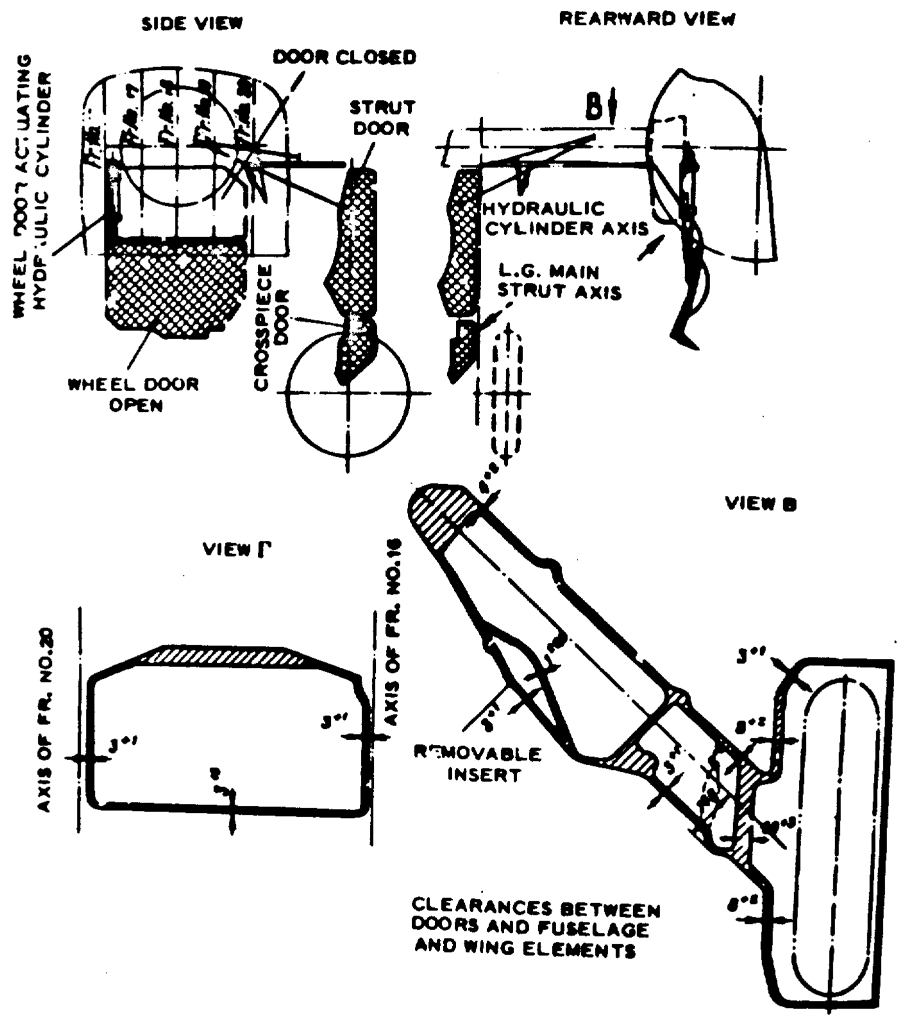


FIG.93. L.G. MAIN STRUT DOORS

hydraulic cylinder, extends the rod which sends the strut in the down position and, through the bolt with the lever actuates the wheel turning mechanism.

In the down position the strut is held by the hydraulic and mechanical locks.

The main strut emergency extension is performed by the air system. For this purpose the L.G. control is shifted to the DOWN position and the L.G. emergency extension valve is switched on. The air enters the air cylinder of the strut lock and shifts the rod. In its movement the rod pushes the cam lever and opens first the wheel door lock and then the main strut door lock.

Having passed through the main strut lock actuating cylinder the air enters the extension and retraction hydraulic cylinder, extends the strut and fixes it in this position by the mechanical lock.

L.G. Position Warning System

The up and down positions of the landing gear main struts are checked by means of an electrical warning system (Fig.94) through the agency of green and red lights located on the ППС-2 panel in the pilot's cockpit. The lights are switched on and off by limit switches. The limit switch of the L.G. down position is mounted on the bracket under the wing skin and the limit switch of the L.G. up position is arranged on the up-lock body.

When the main strut is extended, the stop on the upper attachment unit of the strut sleeve presses the limit switch rod and the green light flashes up on the ППС-2 panel indicating the extension of the respective L.G. strut.

The limit switch of the L.G. down position is installed so that the green light comes on only after the strut has almost taken the full down position.

When the strut is being retracted, the stop leaves the limit switch and the green light indicating the position of the respective strut goes out.

The strut retracted, the lever of the lock presses the limit switch rod and, the moment the up-lock snaps the strut in the up position, the red light flashes up on the ППС-2 panel indicating that the main strut lock is closed and the strut is retracted.

The L.G. up position limit switch rod is so adjusted that the lever presses the rod the moment the lock closes.

II. DRAG CHUTE SYSTEM

1. General

The drag chute is intended to decrease the aircraft landing roll.

The drag chute, type ПТ-21(Fig.95), is released at landing the moment the main wheels touch the ground.

While the drag chute is being filled with air, a moment is created to make the nose wheel move down and contact the ground.

The drag chute is packed in a special easily removable container and placed into the fuselage tail section well (between frames Nos 30 and 32) at the left side.

The container with the drag chute is fastened at four points: by two pins 25 which enter boxes 29 and by two pins 23 for quick-release hooks 27.

Drag chute cable 5 is arranged in a channel located on the dorsal fin and at the fuselage bottom and is fastened by special clamps.

In the closed position the container well doors are locked by two mechanical locks: retaining lock 1 and door lock 30. Pneumatic cylinder 4 for opening the well doors is fastened to frame No.32.

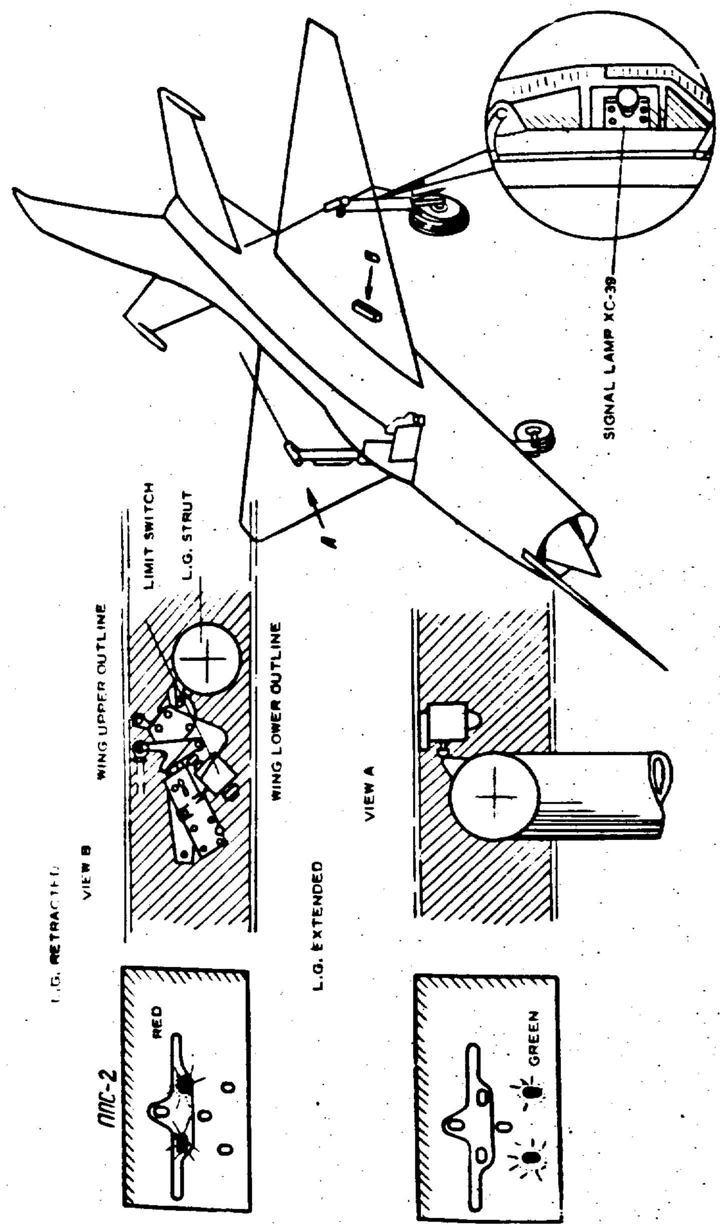


FIG. 94. L.G. MAIN STRUTS POSITION WARNING SYSTEM

The well doors are held opened by special spring mechanism 2. The spring mechanism of each well door includes a guide rod with a spring and a bell-crank. When the well doors are closed, the springs are compressed; they press against the door trying to open them.

2. Arrangement

Packing of Drag Chute into Container

To pack the drag chute into the container it is necessary to remove the container from the aircraft, open the doors by means of a hexahedral wrench or by pressing button CHUTE RELEASE (ВЫПУСК ПАРАШЮТА) and then to open the lock by pulling locks cable 28 (Fig.95).

Having turned the drag chute system so that the auxiliary chute is on top and the cable is below, pack the chute tightly into the container.

Having pulled out the auxiliary chute from the cover pocket, close all the flaps: front, rear, upper and lower; place the auxiliary chute above the rear flap.

Pass the cotter pin operating cable through the additional flap, set the cotter pin in the upper and lower flaps and close the latter with a protective flap.

Installation of Container into Aircraft Hatch

To install the container with the chute into the aircraft hatch, insert the container with pins 25 into the seat of container suspension box 29 and turn the container till the locks snap, having pulled the cable. During this operation the container pins engage hooks 27 which are held in the closed position by springs 26.

By folding bell-cranks 20, close hatch doors 19 and 22. Then use a hexahedral wrench and close hatch doors lock 30 and retaining lock 1, according to the inscriptions at the locks. After this fix the retaining lock by means of wire K2-K1.

Packing of Chute Cable

Chute cable 5 with capron insert 8 is packed in the channel running on the dorsal fin and at the fuselage bottom and is fixed by special clamps. The end of the cable which is capron insert 8 is secured to hook 7 of the suspension lock and is bound by means of wire and twine, according to the engravings.

3. Drag Chute Control System

The drag chute control system (Fig.95) includes the following units:

(a) the air cylinder for opening the lock doors, arranged at the fuselage bottom at frame No.32;

(b) the air cylinder for dropping the drag chute;

(c) the cable holding lock mounted on the dorsal fin of the fuselage tail section;

(d) the button labelled CHUTE RELEASE (ВЫПУСК ПАРАШЮТА) set on the instrument panel;

(e) the button labelled CHUTE DROPPING (СБРОС ПАРАШЮТА) arranged on the left-hand console in the aircraft cockpit;

(f) two electropneumatic valves 695000M to control opening of the well doors and dropping of the chute;

(g) the air pipes and electric wires.

Drag Chute Releasing System

To release the chute press the button engraved CHUTE RELEASE.

In this case the positive voltage is supplied to electropneumatic valve 695000M which operates and passes the air from the air system to the pneumatic cylinder actuating the well doors lock. (For details see Chapter V of this book

When the well doors are being closed, rod 13 enters with its tip the seat of pneumatic cylinder 4 and the retaining lock shaft enters the seat of the bracket on the door.

When the bar of the pneumatic cylinder shifts, rod 13 engages retaining lock shaft 15 and makes it leave its seat.

The well doors actuated by their spring mechanisms open and are locked in their full open position.

After the well doors are opened and fixed in this position,the drag chute the container by gravity. After the auxiliary chute gets filled with air, it pulls the cover from the drag chute which gets opened by a flow of air.

The released chute is held by hook 7.

Drag Chute Dropping System

To release the chute (Fig.95) from hook 7, press button CHUTE DROPPING. In this case the second electropneumatic valve 695000M operates and gives way to the flow of air into the chute dropping pneumatic cylinder.

Shifting rod 6 turns bell-crank 9 which has a shaft with a special cut-out. When the lock is closed, the shaft prevents hook 7 from turning. When the lock opens, it makes the shaft rotate till its cut-out is located against hook 7 which now can rotate freely.

Actuated by the drag chute, the lock opens, the chute cable gets released from the lock and the chute is dropped down.

After this the drag chute is assembled and sent to the parachute section where it is packed up in accordance with the Technical Description and Packing and Mounting Instructions for Drag Chute System ПТ-21.

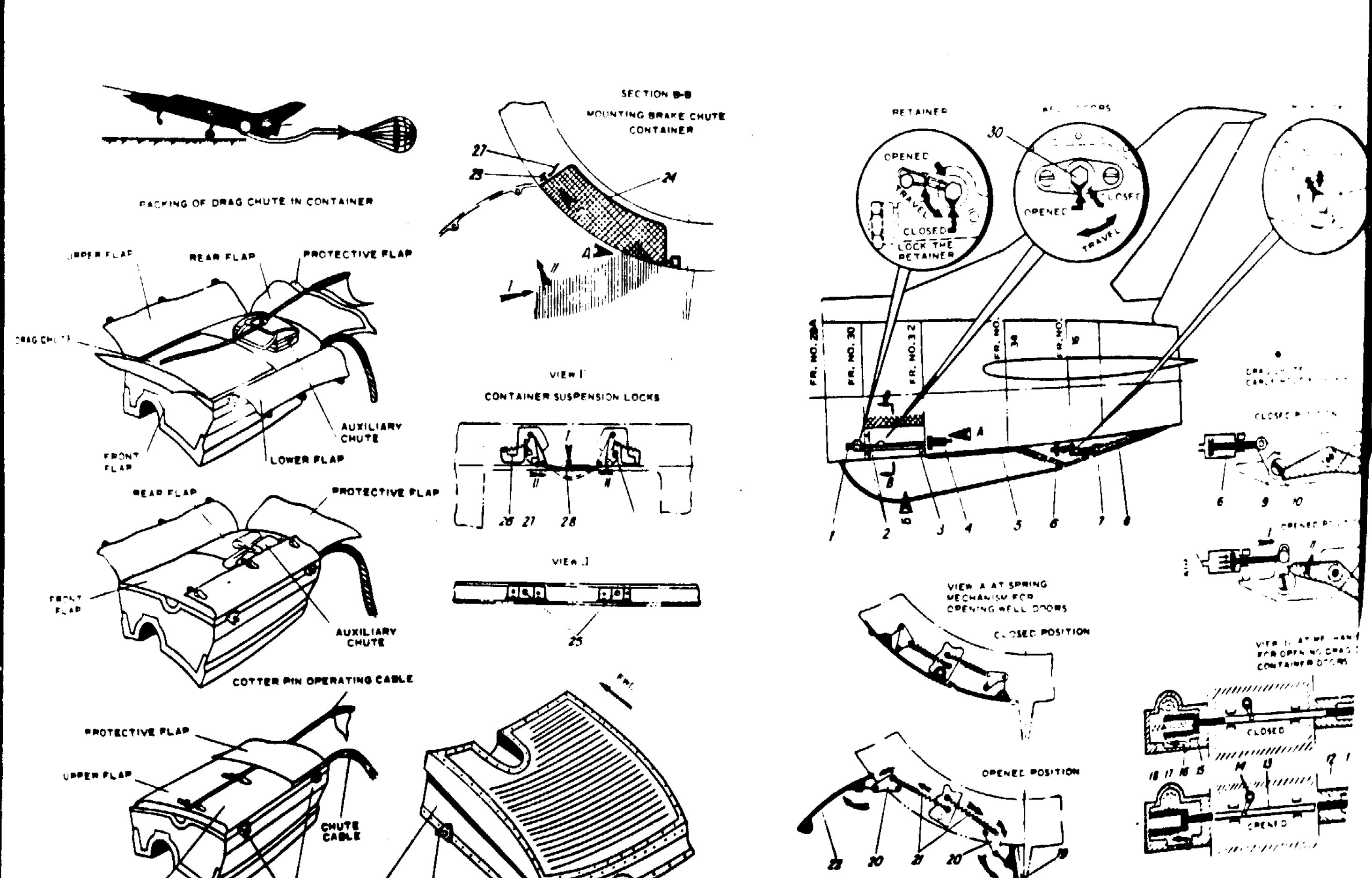


FIG.95. BRAKE CHUTE ASSEMBLY

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Chapter V

AIR AND HYDRAULIC SYSTEMS

AIR SYSTEM

General

The aircraft air system consists of two separate systems: the main and the emergency systems (Fig.96).

The main air system is intended to perform the following functions:

(1) braking of the landing gear wheels;

(2) closing of the fuel shut-off cock;

(3) lifting and sealing of the canopy;

(4) controlling of the doors and jettisoning of the drag chute;

(5) cutting-in of the de-icer system;

(6) closing of the compartments cooling valve.

The emergency air system ensures emergency extension of the landing gear and emergency braking of the landing gear main wheels.

The source of energy for the air system is compressed air which is stored in and consumed from the air bottles located in the aircraft.

Replenishment of compressed air is accomplished by recharging the system on the ground from a ground source of compressed air delivered at a pressure of 110 - 130 kg/cm^2.

The air used in the air system should be clean and dry with the dew-point not above -30°C.

The pressure in the system is measured by 2M-150 two-pointer pressure gauge 3.

To brake the L.G. wheels, to control the drag chute system, shut-off cock, canopy, de-icer system, compartments cooling valve and to brake the L.G. wheels in an emergency, the compressed air should be supplied at a reduced pressure.

For this purpose the system uses air reducers which reduce the pressure down to the required working pressure in a respective line of the system.

Installed in the main system after the air bottles is PB-50M reducer 43 which reduces the pressure from 110 - 130 kg/cm^2 to 50 kg/cm^2; this pressure is delivered to all the lines of the main system, except for the pipe of canopy emergency jettisoning air bottle 25, in which the pressure of 110 - 130 kg/cm^2 is used.

In the L.G. wheel brake system there is ПУ-7 reducing valve 31 and two УП-24/2 pressure amplifiers 38. The pressure reduced by valve ПУ-7 is delivered to pressure amplifiers УП-24/2 where it is increased twofold.

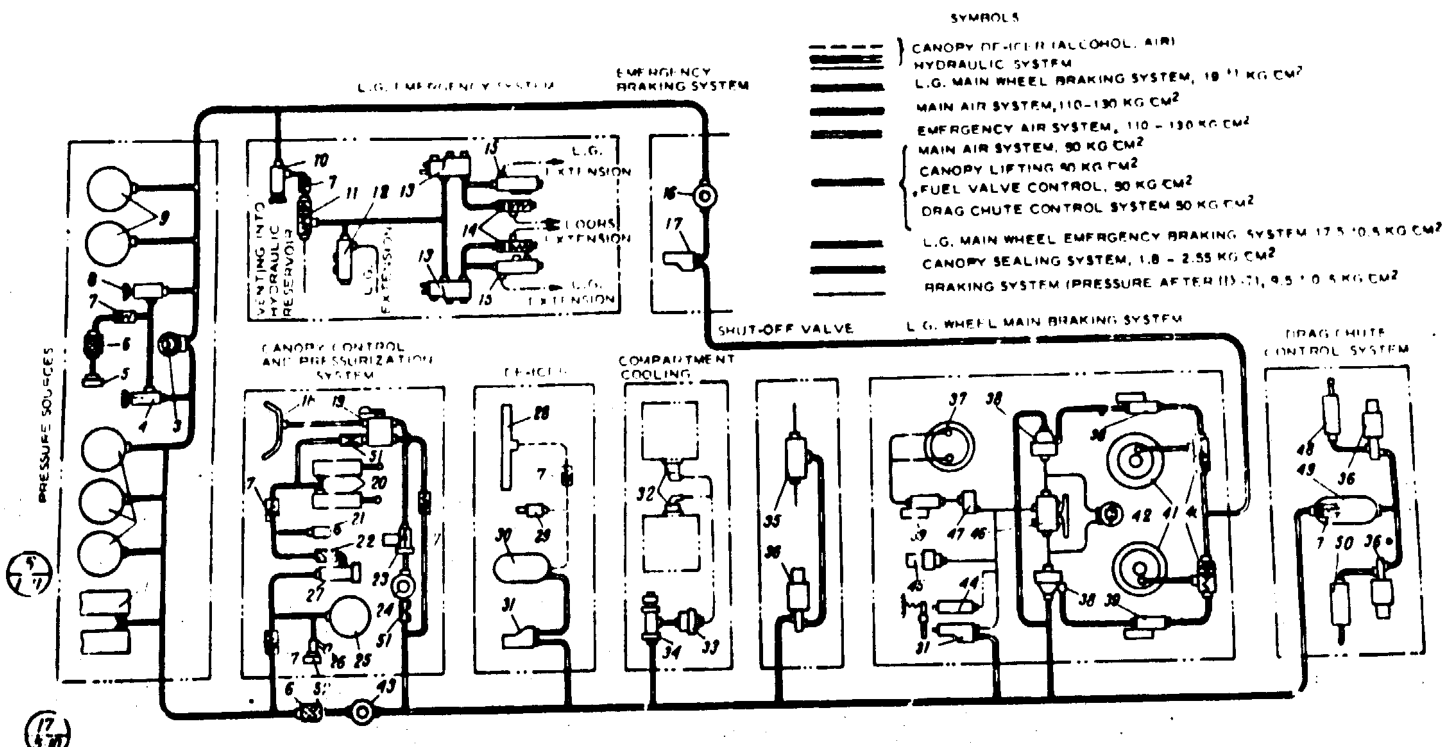
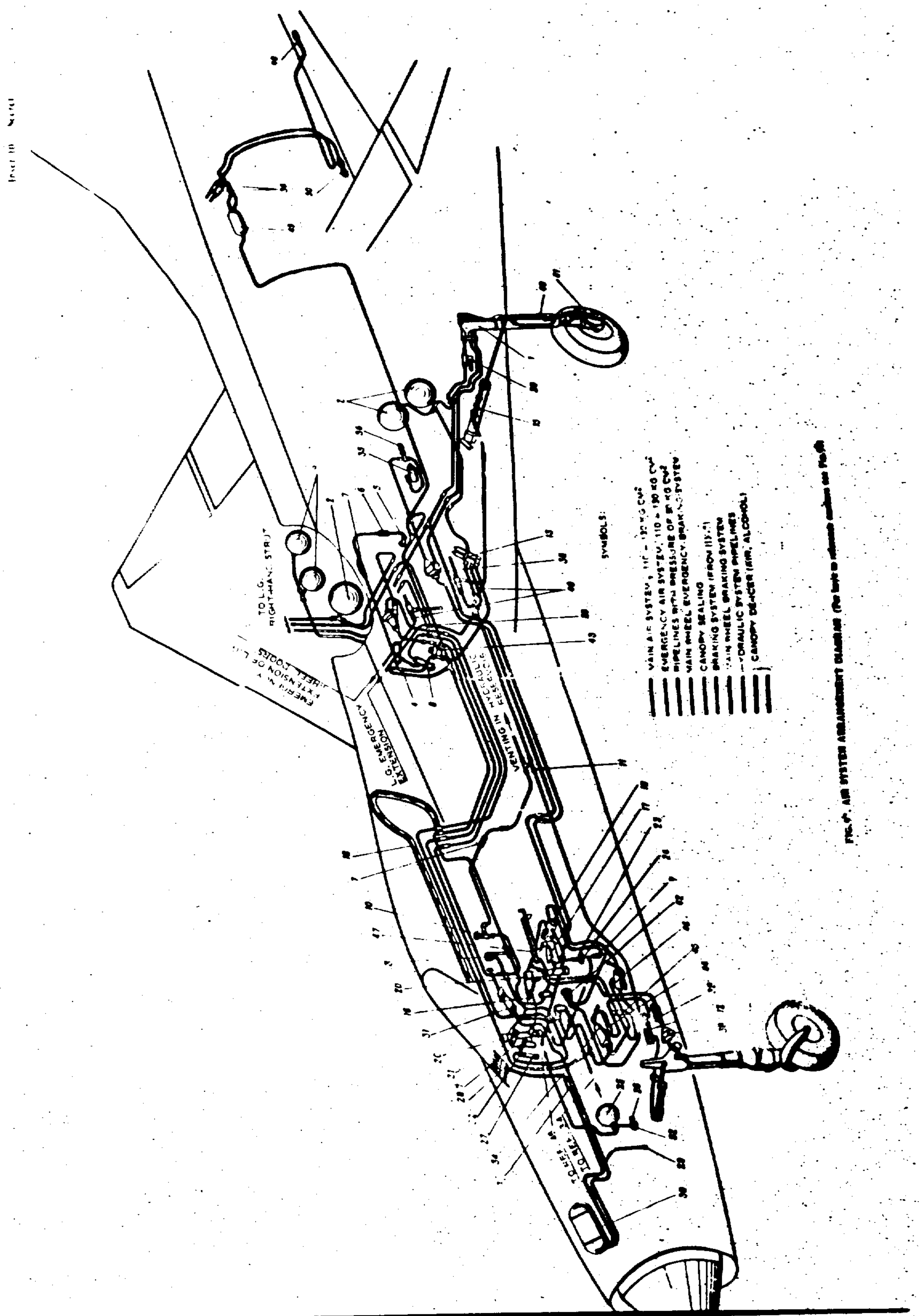


FIG. 96. SCHEMATIC DIAGRAM OF AIR SYSTEM

1 – main system bottles, 2.25 lit. capacity each, located in main struts; 2 – main system bottles, 2 lit. capacity each; 3 – twopointer air pressure gauge 2M-150; 4 – main system charging valve; 5 – aircraft charging connection; 6 – air strainer; 7 – return valve; 8 – emergency system charging valve; 9 – emergency system bottles, 1.5 lit. capacity each; 10 – L.G. emergency extension valve; 11 – vent valve; 12 – L.G. nose strut hydraulic lock; 13 – L.G. main strut up-lock cylinder; 14 – emergency valve; 15 – L.G. main strut hydraulic lock; 16 – emergency braking reducer PR-50M; 17 – reducing valve; 18 – canopy pressurization hose; 19 – canopy control valve; 20 – canopy [illegible] cylinder; 21 – canopy [illegible] cylinder; 22 – strainer; 23 – safety valve; 24 – reducer [illegible] [illegible]

27 – emergency valve (diaphragm valve); 28 – collector; 29 – drain connection; 30 – alcohol tank; 31 – reducing valve [illegible]; 32 – pneumatic valve; 33 – air throttle; 34 – pneumatic valve [illegible]; 35 – fuel shut-off valve; 36 – electropneumatic valve 695000 M; 37 – nose strut wheel KT-38; 38 – pressure amplifier [illegible]; 39 – electromagnetic servovalve [illegible]; 40 – emergency switch; 41 – main strut wheel KT-92; 42 – braking system twopointer pressure gauge MII-12; 43 – reducer [illegible]; 44 – automatic braking cylinder; 45 – [illegible] switch; 46 – differential valve [illegible]; 47 – valve [illegible] in switch on nose strut braking system; 48 – chute dropping cylinder; 49 – air bottle of chute control system; 50 – drag chute doors opening cylinder; 51 – throttle; 52 – pressure gauge [illegible]



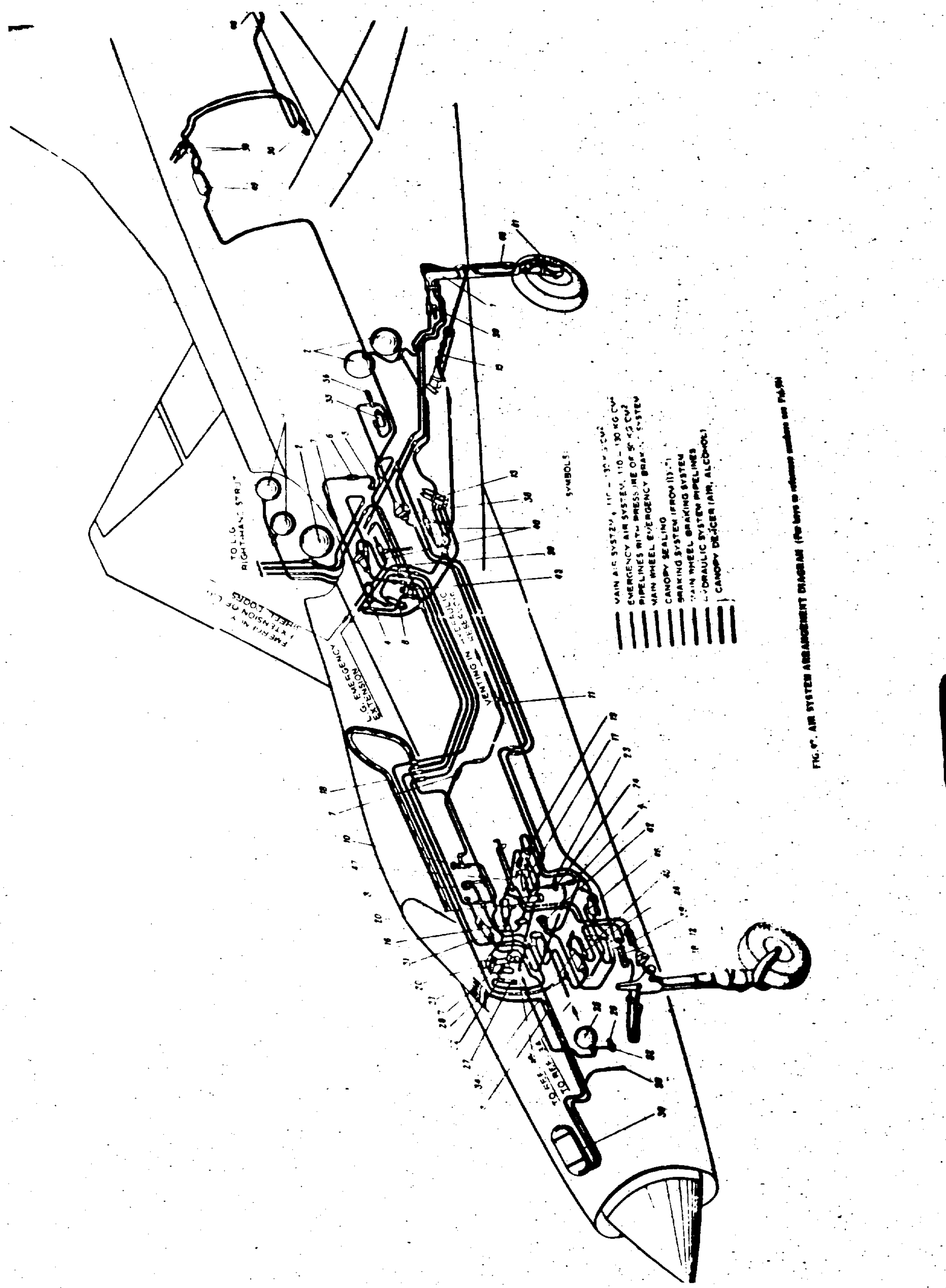


FIG. [illegible]. AIR SYSTEM ARRANGEMENT DIAGRAM [illegible]

ГУ-7 reducing valve 31 to reduce pressure down to 3 kg/cm^2 is installed in he de-icer system.

In the canopy control system PB-1,5 reducer 24 decreases the pressure used or the canopy sealing down to 1.8 - 2.55 kg/cm^2.

In the emergency brake system PB-50M reducer 16 reduces pressure from 10 - 130 kg/cm^2 to 50 kg/cm^2; the pressure is further reduced by valve УП-25/2.

To increase the total air reserve and to ensure reliable operation of the vital units, the air system (besides the main air bottles) is provided with supplementary air bottles storing air for each of the following lines and systems: the lines for dropping and releasing of drag chute (bottle 49), and canopy emergency jettisoning system (bottle 25).

These bottles are separated from the system by return valves 7; they can supply air only to those units in the control lines of which they are installed.

Under working conditions each of the systems is shut off by its own valve, which prevents leakage of air from one system to another.

Air System Specifications

1. Capacity of main air bottles (three spherical bottles and two bottles in L.G. struts) .... 10.46 lit.
2. Capacity of emergency air bottles (two spherical bottles, 1.3 lit. each) .... 2.6 lit.
3. Pressure in air bottles of main and emergency systems .... 110 - 130 kg/cm^2
4. Pressure in KT-38 wheel brake line of L.G. nose strut .... 9.5 ± 0.5 kg/cm^2
5. Pressure in KT-92 wheels brake line of L.G. main struts .... 19 +1 kg/cm^2
6. Pressure in KT-92 wheel emergency brake line ...... 17.5 ±0.5 kg/cm^2
7. Pressure in air bottle for canopy emergency jettisoning .... 110 - 130 kg/cm^2
8. Pressure supplied to fuel system shut-off cock, canopy lifting system, chute control system and to fuselage compartments cooling valves .... 50 kg/cm^2
9. Pressure in canopy de-icer system .... 3 kg/cm^2
10. Pressure in canopy sealing system .... 1.8 - 2.55 kg/cm^2

1. Pressure Sources
(Fig.98)

The main system uses the following compressed air containers:

(1) three spherical bottles 2, 2 lit. capacity each;

(2) two cavities 1, 2.23 lit. capacity each (one of the cavities is located in the upper portion of the L.G. right strut and the other - in the upper part of the L.G. left strut).

Installed in the emergency system are two spherical bottles 9, 1.3 lit. capacity each.

The air bottle charging line, which is common for both the main and the emergency systems, comprises: inboard charging connection 5, air strainer 6, air return valve 7, two valves 4 and 8.

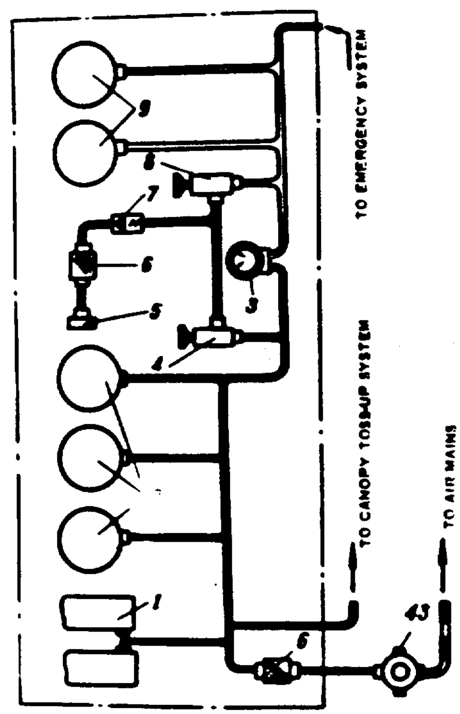


FIG. 98. PRESSURE SOURCES (Reference numbers are as in Fig. 96)
1 – main system bottles located in main struts; 2 – main system bottles; 3 – two-pointer air pressure gauge; 4 – main system charging valve; 5 – aircraft charging connection; 6 – air strainer; 7 – return valve; 8 – emergency system charging valve. 9 – emergency system bottles; 43 – reducer PH-50M.

Pressure is measured by 2M-150 two-pointer air pressure gauge 3.

2. Units of System Charging Pipelines

Aircraft Charging Connection (Fig.99)

The aircraft charging connection is intended for coupling the ground pressure source hose with subsequent charging of the air system.

The charging connection is of quick-release sealed type.

The aircraft connection consists of body 1 and plug 3 connected with the body by means of wire cable 2.

Inserted into the body is packing rubber gasket 4; the outlet connection is jointed with the system pipeline.

The plug is locked by plate spring 5. The spring is riveted to the plug holder and by its tooth on the movable end engages the corresponding lug on the body.

The inboard charging connection is located in the wheel right-hand well on frame No.20.

Air Strainer (Fig.100)

The air strainers located in the bottle charging line and before reducer PB-50M are designed for cleaning the compressed air from mechanical impurities. The air strainer consists of cover 1 and body 6.

The cover and the body, being connected by means of a union nut, form the inner cavity which houses a filtering element. The filtering element comprises felt washers 4, gauzes 5 and supports 7, braced on shaft 8.

Rubber ring 3 packs the body-to-cover joint. Compressed air can be supplied to any connection.

Return Valve (Fig.101)

The return valve passes the compressed air only in one direction and prevents its flow in the reverse direction. The valve consists of cover 4, body 1, valve 2 and retracting spring 3. The end face rubber packing ensures airtightness of valve 2 in closed position.

To prevent wrong connection of the return valve in assembly, the valve body bears an arrow, showing the direction of air flow.

Charging Valve (Fig.102)

Installed in the charging lines of the main and emergency systems as well as in the landing gear emergency extension line are valves similar in construction except for the stencilled inscriptions and the handwheels.

The valves in the charging line are designed to shut off the system or to connect it to the ground pressure source.

The valve in the L.G. emergency extension system serves to associate the air bottles with the strut and door actuating cylinders.

The valve consists of body 1, cover 4, nut 9, shaft 3, handwheel 8 and valve 12.

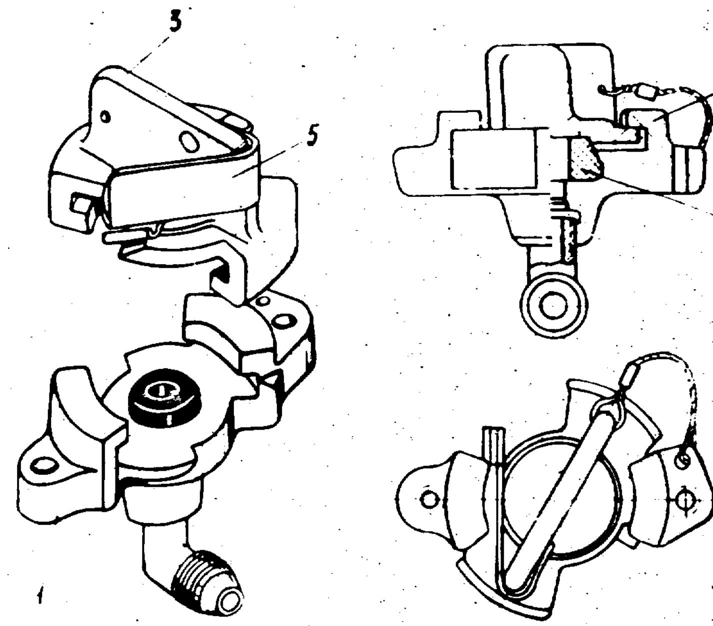


FIG.99. AIRCRAFT CHARGING CONNECTION
1 – body; 2 – cable; 3 – plug; 4 – rubber gasket; 5 – plate spring.

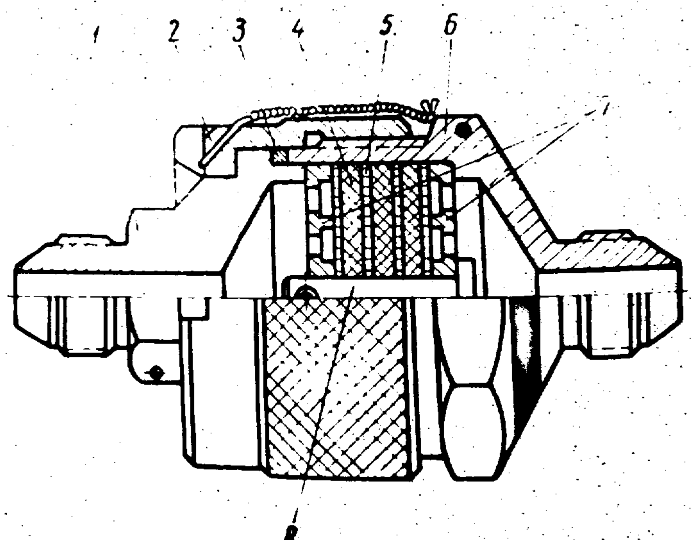


FIG.100. AIR STRAINER
1 – cover; 2 – union nut; 3 – packing ring; 4 – felt washer;
5 – gauze; 6 – body; 7 – supports; 8 – shaft.

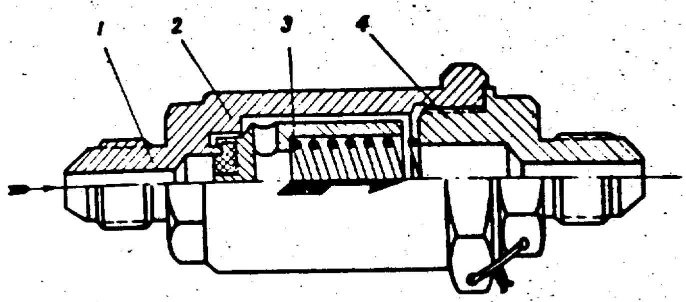


FIG.101. RETURN VALVE
1 – body; 2 – valve; 3 – retracting spring; 4 – cover.

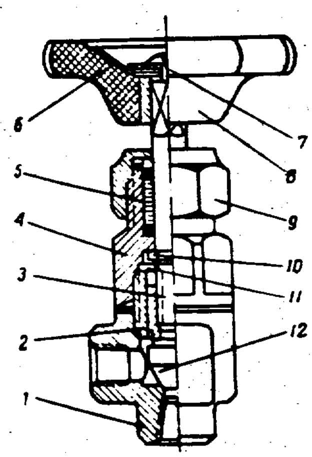


FIG.102. CHARGING VALVE
1 – body; 2 – bushing; 3 – shaft; 4 – cover; 5 – packing ring; 6 – nameplate; 7 – screw; 8 – handwheel; 9 – nut; 10 – ring; 11 – ring; 12 – valve.

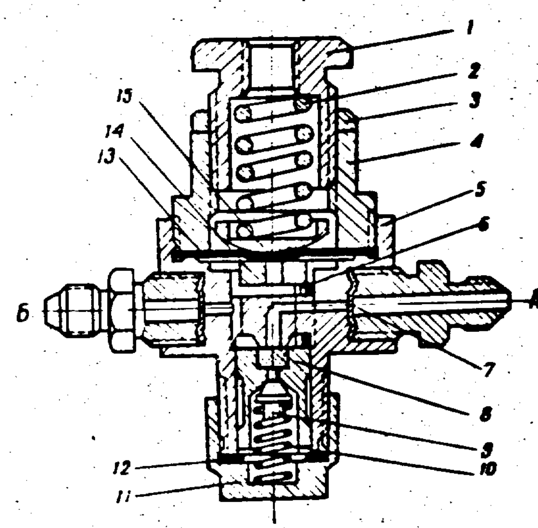


FIG.103. PH-50M REDUCER
1 – adjusting cover; 2 – reducing spring; 3 – locknut; 4 – sleeve; 5 – body; 6 – tappets; 7 – sealing washers; 8 – inlet valve; 9 – supporting cone; 10 – retracting spring; 11 – cover; 12 – gasket; 13 – diaphragm; 14 – bushing; 15 – supporting washer.

When the handwheel is turned, the shaft associated with it is turned too; the shaft is kept from translatory movement by ring 10 against which it rests. Valve 12 is thread-connected with the shaft; therefore, it cannot turn but will make translatoty movements to close and open the valve.

The body has a seat against which valve 12 rests closing the valve in the screwed-in position of the shaft.

One connection on the valve body communicates with the pressure line, while the other is connected with the cut-off portion of the system. When the shaft is screwed out by the handwheel, the valve shifts from the seat and the pressure line is connected with the cut-off portion of the system.

The main system charging valve has the inscription: SYSTEM CHARGING (ЗАРЯДКА СЕТИ) marked on the handwheel and the valve of the emergency system has the inscription: EMERGENCY BOTTLE CHARGING (ЗАРЯДКА АВАР. БАЛЛОНА).

The valve of the landing gear emergency extension has a special handle of red colour. It bears inscription EMERG. L.G. (АВАР. ШАССИ). The charging valves are installed in the wheel right-hand well and the L.G. emergency extension valve - in the cockpit on the right-hand console.

PB-50M Reducer (Fig.103)

The PB-50M reducer serves to reduce air pressure in the main system from 110 - 130 kg/cm^2 down to 50^{+7}_{-1} kg/cm^2.

The reducer consists of body 5 with two connections (connection A for air inlet and connection Б for air outlet), inlet valve 8, diaphragm 13, and reducing spring 2.

When pressure is delivered to connection A, the compressed air flows through the inner duct and the opened inlet valve to the outlet connection. At the first moment after pressure application the inlet valve is kept compressed by gradually reducing spring 2 through the action of tappets 6.

The compressed air at 50 kg/cm^2 flows under the diaphragm and gradually contracts spring 2 to shift supporting washer 15 and tappets upward, and thus shuts the inlet valve through retracting spring 10.

As the air in the system is being consumed, the pressure under the diaphragm drops and the reducing spring through the supporting washer and the tappets will open the inlet valve, thus ensuring the supply of compressed air from the charging bottles.

The PB-50M reducer operates continuously maintaining the pressure in the system within 50^{+7}_{-1} kg/cm^2.

Should the pressure in the main bottles drop down to 50 kg/cm^2 or lower, the reducer would pass the remaining volume of air into the system, the inlet valve being constantly kept open.

Installed in the reducer body is a safety valve, adjusted to a pressure of 60^{+15}_{-2} kg/cm^2.

In case the reducer fails to operate, the safety valve releases the excessive pressure into the atmosphere. Reducer PB-50M is installed in the cockpit.

Pipelines

The air system units are interconnected by means of pipelines made of type AMTM pipes. The rolling out of the pipes is carried out in accordance with Standard 100AT55 (for the duralumin and steel pipes). The pipes are attached to the connections of the units and fittings in accordance with Standard 100OA55.

The pipeline of the air system is painted black. To facilitate pipe dif-erentiation the pipes of any one system have special marking.

For this purpose the pipes bear the name of the system to which they belong. he inscription is marked at the nut and is stretched along the whole length of he pipe. Some inscriptions are given fully: CHUTE DROPPING (СБРОС ПАРАШЮТА), r PRESSURIZATION (ПОДДАВЛИВАНИЕ). Others are given in a shortened way, e.g. OSE WHEEL BRAK. (ТОРМОЗ. ПЕРЕДН. КОЛЕСА)which means that the pipe bearing this nscription belongs to the braking system of the L.G. nose wheel.

The pipelines are fastened by flexible clamps when they run separately by ne and by means of multi-socket blocks, when they run in bundles.

In the air system the hoses are employed at places where pressure is required o be fed through movable elements. The hoses are installed on the L.G. struts t the places where the pressure is supplied to the L.G. wheel brakes. This hose rrangement is explained by the fact that the wheels shift during shock absorp-ion. Besides, the hoses are installed at the transition places between the ipeline mounted on the main struts and the pipeline in the wing, to ensure strut ovement during L.G. extension and retraction.

Air Bottles (Fig.104)

The air bottles are welded of sheet metal, grade 30ХГСА.

The spherical bottles of the main and emergency systems are welded of two emi-spheres. One bushing 5 is designed to fasten the bottle and the other 2, to ount connection 1. The latter is installed on copper sealing gasket 6.

The cylindrical bottles consist of a shell and two spherical bottoms.

Mounted in the bushings welded along the bottle axis are connections through hich the bottles are attached to the system.

All the high-pressure bottles are manufactured in accordance with the xisting standards.

The nameplates on the bottle bodies bear brief Specifications and the date f the forthcoming check.

3. Wheel Brake System (Fig.105)

The brake system ensures manual control of the L.G. main and nose heel brakes.

The brake system comprises the following units:

(a) ПУ-7 (У1-39) reducing valve 31;
(b) ПУ-8 (У1-35) differential valve 46;
(c) УП-24/2 pressure amplifier 38;
(d) МВ-12 two-pointer pressure gauge 42;
(e) three УП-53/1-2 electromagnetic servovalves 39;
(f) УП-22 switch 45;
(g) УП-33/1 nose strut wheel brake valve 47;
(h) two 563600М emergency switches 40.

The УП-53/1-2 and УП-22 units complete with the УА-24/2М-5 inertia ick-up of the КТ-38 nose wheel and the УА-23/2М-13 (for the right КТ-92 wheel) nd УА-23/2М-14 (for the left КТ-92 wheel) inertia pick-ups have their own lectrical circuits and ensure automatic release of the wheels when one of the heels skids.

The detailed description of the system will be given below.

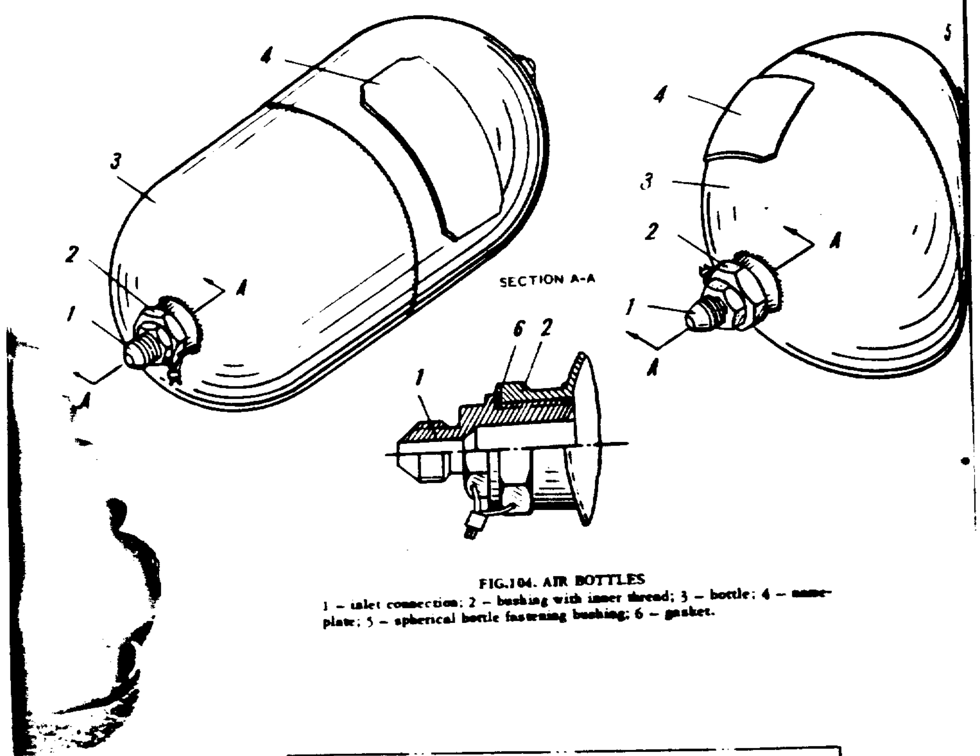


FIG.104. AIR BOTTLES
1 – inlet connection; 2 – bushing with inner thread; 3 – bottle; 4 – name-plate; 5 – spherical bottle fastening bushing; 6 – gasket.

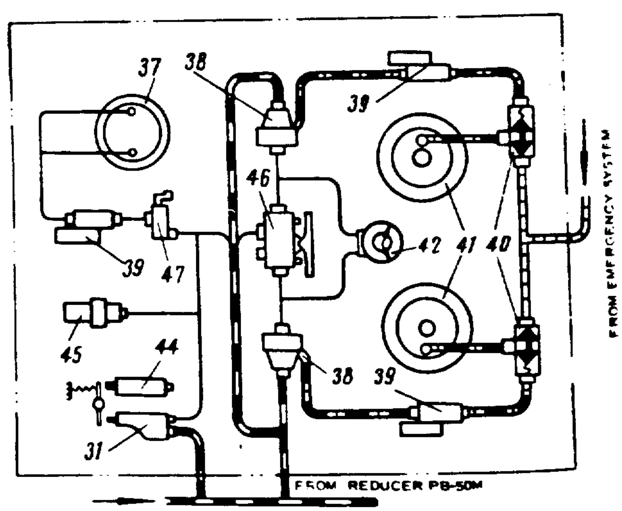


FIG.105. WHEEL BRAKE SYSTEM (Reference numbers are as in Fig.96)
31 – reducing valve ПУ-7(У1-39); 37 – nose strut wheel KT-38 ; 38 – pressure amplifier УП-24/2; 39 – electromagnetic servovalve УП-53/1-2; 40 – emergency switch; 41 – main strut wheel KT-92; 42 – braking system two-pointer pressure gauge MB-12; 44 – automatic braking cylinder; 45 – УП-22 switch; 46 – differential valve ПУ-8(У1-35); 47 – valve УП-33/1 to switch on nose strut braking system.

To brake the L.G. wheels by the main system, the pilot should depress the brake lever located on the control stick.

When the brake lever is depressed, the motion is transmitted to the rod of the ПУ-7 reducing valve.

Depending on the pressing effort of the brake lever, the ПУ-7 valve reduces the pressure of 50 kg/cm^2 fed to it from the system to a definite value and supplies the compressed air through the ПУ-8 differential valve, whose lever is coupled kinematically with the foot control pedals, to the УП-24/2 pressure amplifiers of the main wheels.

The air from the ПУ-7 valve is fed to the УП-24/2 pressure amplifiers as control pressure, where the compressed air delivered to them under the pressure of 50 kg/cm^2 is increased with ratio 2 (depending on the control pressure), i.e. the air delivered to the main wheels has a pressure two times higher than the control pressure supplied from the ПУ-7 reducing valve.

This ratio is constant and does not change at any braking effort. Therefore the pressure on the main wheels is always two times higher than the control pressure.

From the amplifier the pressure is fed to the main wheel brake cylinders through the servovalves, throttles and emergency valves.

When the aircraft is being taxied on the ground, turns can be performed by releasing one of the L.G. wheels. In this case the foot pedal should be shifted to transmit motion through the connecting rod to the ПУ-8 differential valve; this will result in release of one of the L.G. wheels. The aircraft will perform the turn proportional to the deflection angle of the pedal relative to the braked wheel.

The nose wheel brake is applied at the pilot's will by means of the УП-33/1 valve in accordance with the landing conditions (wet or icy ground) when it is necessary to decrease the aircraft landing roll. To do this, the pilot should cut in the УП-33/1 brake valve and the air from ПУ-7 through the servovalve will be delivered to the nose wheel brake cylinders.

The pressure in the main wheels brake cylinders is checked by the МВ-12 two-pointer pressure gauge.

When the landing gear is being retracted at take-off, the fluid pressure in the hydraulic system actuates the wheel automatic brake cylinder.

In this case the pressure after the ПУ-7 reducing valve should be within 3 - 4 kg/cm^2 which is obtained by adjusting the length of the rod of the automatic brake cylinder with an adjusting bolt.

After the wheels have been retracted and the L.G. control set in the NEUTRAL (НЕЙТРАЛЬНО) position, the retracting spring returns the cylinder rod to the initial position and the wheel brakes get released.

If the brakes have been applied by the lever on the control stick, the wheels can be released by discharging the air from the brake lines, for which purpose the lever should be released. In this case the control pressure is released from the УП-24/2 amplifiers through the ПУ-7 valve. The compressed air is discharged from the wheels brake cylinders through the УП-24/2 pressure amplifiers.

In the process of the aircraft ground run it is possible to change over from the ordinary braking system to the braking with the use of the automatic brake wheel release system.

For this purpose the circuit-breaker WHEEL BRAKE CONTROL UNIT (АВТОМАТ ТОРМОЖЕНИЯ КОЛЕС) should be set in the ON (ВКЛЮЧЕН) position without releasing the brake lever.

To change over to the ordinary braking system first release the brake lever set circuit-breaker АЗС-5 switch to the OFF (ВЫКЛЮЧЕН) position and perform braking.

The electric circuit of the wheel brake release system is closed by the УП-22 switch at a pressure of 0.5 to 0.7 atm.

Thus, cutting-in of the WHEEL BRAKE CONTROL UNIT toggle switch does not supply power to the УП-53/1-2 servovalve, to the УА-24 and УА-23 inertia pick-ups.

The release system is ready for action only after the УП-22 switch has been operated.

When one of the wheels starts skidding the УА-23 pick-up closes the circuit and the current flows to the respective УП-53/1-2 servovalve which releases the air from the brake cylinders and simultaneously cuts off the pressure supply from the pressure amplifiers. Skidding eliminated, the pick-up stops sending the release electric pulse.

In the automatic wheel brake system use is made of some kind of blocking which comes to this: in case the pick-up of one of the main strut wheels operates the brakes of this wheel and the nose wheel brakes get released.

Should the nose wheel pick-up operate, the main wheel brakes will not be released.

4. Brake System Units

ПУ-7 (У1-39) Reducing Valve (Fig.106)

The ПУ-7 reducing valve serves to deliver compressed air to the brake system and to reduce simultaneously the pressure supplied to it from the main system.

The pressure fed from the ПУ-7 reducing valve to the pressure amplifiers control pressure is proportional to the tappet travel; the motion to the tappet is transmitted through a special lever, which is set into operation from the brake lever on the control stick.

The air from the system is supplied to the A connection of the valve under the pressure of 50 kg/cm^2, but it does not flow to the brake system unless the brake lever is depressed.

At the same time the brake system coupled with the Б connection communicates with atmosphere through opened small outlet valve 7.

Large and small inlet valves 10 and 11 prevent the compressed air from flowing out of the bottles.

By pressing the brake lever through the two-arm lever the pilot depresses tappet 1 of the ПУ-7 reducing valve; in this case reducing spring 5 will shift piston 3 downward.

Piston 3 with its seat resting on large outlet valve 6 will shift this valve until it contacts small outlet valve 7, thus disconnecting the brake system from the atmosphere.

As the tappet moves further downward, small inlet valve 11 opens. The compressed air from the bottles will flow to the brake system through lower cavity 9 and middle cavity 8 of the ПУ-7 reducing valve.

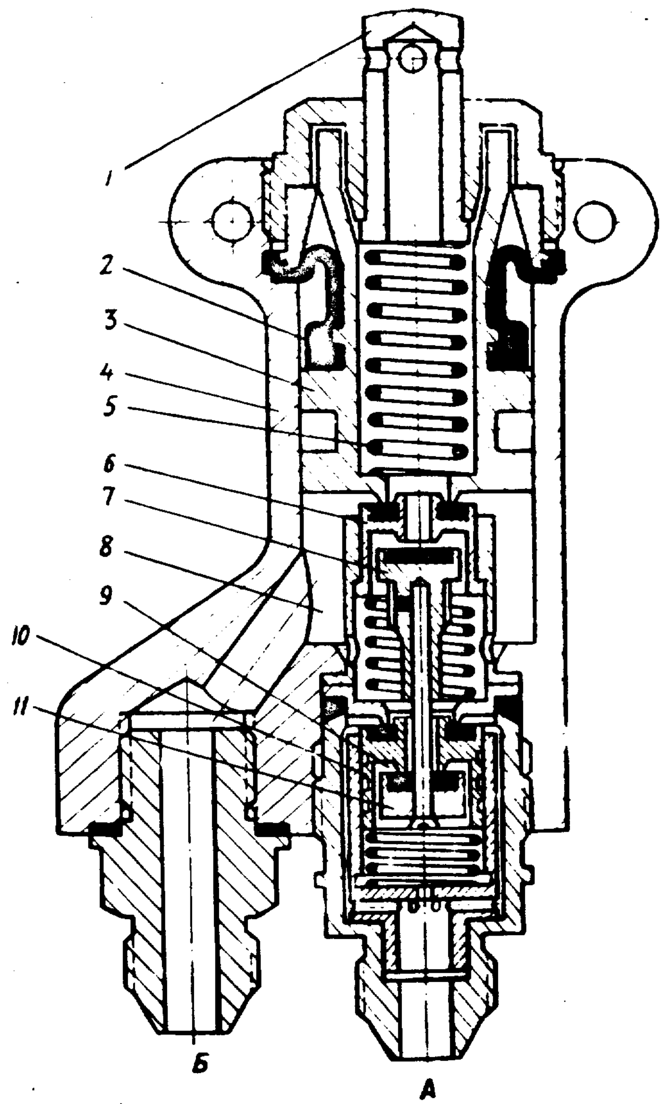


FIG.106. REDUCING VALVE
1 – tappet; 2 – tubular diaphragm; 3 – piston; 4 – body; 5 – reducing spring; 6 – large outlet valve; 7 – small outlet valve; 8 – middle cavity; 9 – lower cavity; 10 – large inlet valve; 11 – small inlet valve.

When small inlet valve 11 opens, the pressure of the air under large inlet valve 10 drops considerably and due to the difference between the pressures above and under the valve the large inlet valve will open the large port for the air to accelerate the braking process.

Should the necessity arise to quickly release the L.G. wheel brakes, release the brake lever on the control stick; this done, the tappet gets free, the piston rises upward, the piston seat travels away from the large outlet valve and opens the large port for discharging the compressed air to the atmosphere, thus accelerating the brake release process.

The small inlet and outlet valves ensure gradual braking; while the large valves help to quickly apply and release the brakes.

The pressure after the ПУ-7 reducing valve is determined by the degree of compression of spring 5, i.e. by the value of the tappet travel.

Installed on the two-arm lever actuating the tappet is an adjusting screw which permits the ПУ-7 reducing valve to be adjusted by the maximum output pressure. The ПУ-7 reducing valve is mounted on the cockpit floor, near the control column. In the Certificate the ПУ-7 reducing valve is designated by the У1-39 number.

ПУ-8 (У1-35) Differential Valve (Fig.107)

The ПУ-8 differential valve provides separate braking of the wheels during taxiing.

In the neutral position lever 1 does not press on rocker arm 2 and therefore the air supplied from the system through the ПУ-7 reducing valve to the A connection of the differential valve shifts pistons 4 until they touch the rocker arm, and through the inlet valve slots the air flows to the differential valve upper chamber and therefrom to the УП-24/2 amplifier as a control pressure.

The differential valve lever end is coupled with the rudder pedals by means of spring reduction rod 7.

Deflection of lever 1 by 15° does not influence the wheel brakes in general.

With greater deflections, lever 1 presses on rocker arm 2 and one of pistons 4, due to the absence of pressure from the roller arm, rises to the seat, and valve 6 stops the compressed air flow into upper chamber II.

Upper chamber II is connected with the right wheel brake chamber, while chamber I is associated with the left wheel chamber.

Under the air pressure trapped in the upper chamber and in the wheel brake, piston 4 rises, leaves valve 6 and opens the outlet port for the compressed air to flow from the brake chambers into the atmosphere through the upper chamber and the piston outlet orifice thereby releasing the right wheel.

The air keeps flowing to the left wheel due to which in the upper chamber I and in the left wheel brake chamber there will be maintained a definite pressure.

When the air is being released, the pressure in chamber II of the differential valve will drop until the difference of pressures in various cavities of the valve acting on the rocker arm through the upper chamber pistons is balanced by the compressive force of the spring inclosed in connecting rod 7. The lever compressing the spring in rod 7 returns to the initial position; after this piston 4 depresses valve 6 and closes the outlet port.

The pressure difference in the cavities of the differential valve corresponds to a definite difference of the wheel braking moments, which is necessary for the aircraft to perform the given turn, since the spring compression force is

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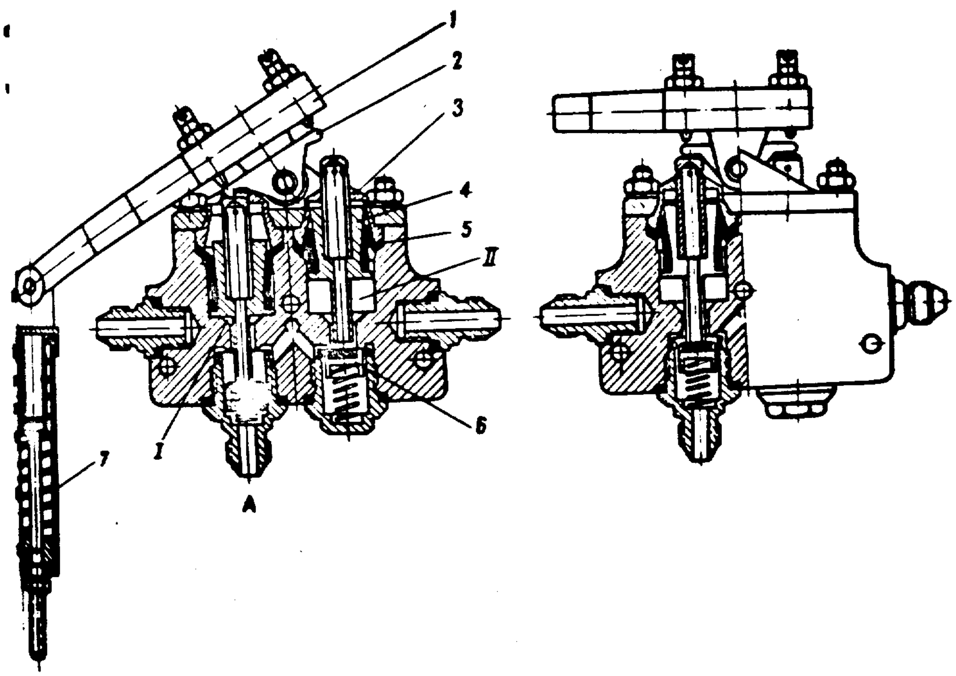

FIG.107. ПУ-8 (У1-35) DIFFERENTIAL VALVE
1 – lever; 2 – rocker arm; 3 – bushing; 4 – piston; 5 – tubular diaphragm; 6 – valve; 7 – reduction rod.

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the connecting rod depends upon the angle of the pedals deflection and does not depend upon the pressure supplied to the differential valve. The ПУ-8 differential valve is mounted near the ПУ-7 reducing valve, on the cockpit floor, in front of the control column, between frames Nos 6 and 7. In the Certificate the ПУ-8 differential valve is designated by the У1-35 number.

УП-24/2 Pressure Amplifier (Fig.108)

The УП-24/2 amplifiers are located in the wells of the L.G. main struts, one in each well.

The amplifiers are designed to supply the wheels with compressed air whose pressure is two times higher than the control pressure delivered from the ПУ-7 reducing valve.

Since the amplifiers are mounted in immediate vicinity of the wheels, the braking cycle is performed more quickly.

Connection of the amplifiers to the main wheel braking lines permits the main wheels to be braked with the pressure in the chambers within 19^{+1} kg/cm^2.

The pressure amplifier consists of body 1, upper and lower diaphragms 2 and control piston 3, inlet valve 7, and outlet valve 6.

The amplifier has three connections:

(a) connection for supplying control pressure;

(b) connection for supplying 50 kg/cm^2 pressure from the air mains;

(c) connection for reduced pressure delivery to the main wheels brakes;

Besides, the amplifier is provided with openings to let out the air from the wheel brake line into the atmosphere when the brakes are being released.

At the moment the control pressure is not delivered, the line supplying pressure from the air mains to the brakes is shut off by the inlet valve and the brake line communicates with the atmosphere. When the control pressure is being fed piston 3 starts travelling downward and in doing so opens the outlet and inlet valves by its tappet, thus providing air supply from the air mains to the brakes.

Simultaneously when the tappet touches the outlet valve end face, the brake line is cut off from the atmosphere.

When the pressure under the control piston increases to a value which balances the pressure above the piston, the control piston will move some distance under the action of spring 8. By this movement the inlet valve returns to its seat and shuts off pressure supply from the air mains hindering further pressure increase in the brakes. At the same time the outlet valve shuts off the line for discharging air from the brakes to the atmosphere. If the control pressure drops, piston 5 will travel upward and the outlet valve will rest on its seat.

The pressure in the brakes starts dropping when the tappet shifts from the outlet valve end face and opens the outlet valve to the atmosphere. Thus, the amplifier responds to absolutely all the changes of the control pressure. The pressure amplification is ensured by selection of proper diameters above and under the control piston. The ratio of these areas equals 2, i.e. for balancing the control piston the pressure under it should be two times higher than the control pressure. The upper and the lower cavities are separated by two diaphragms. There is an outlet port to the atmosphere between the diaphragms.

УП-33-1 Nose Wheel Brake Valve (Fig.109)

The nose wheel brake valve is designed to connect the brake line of the nose wheel with the common wheel brake system.

[redacted]

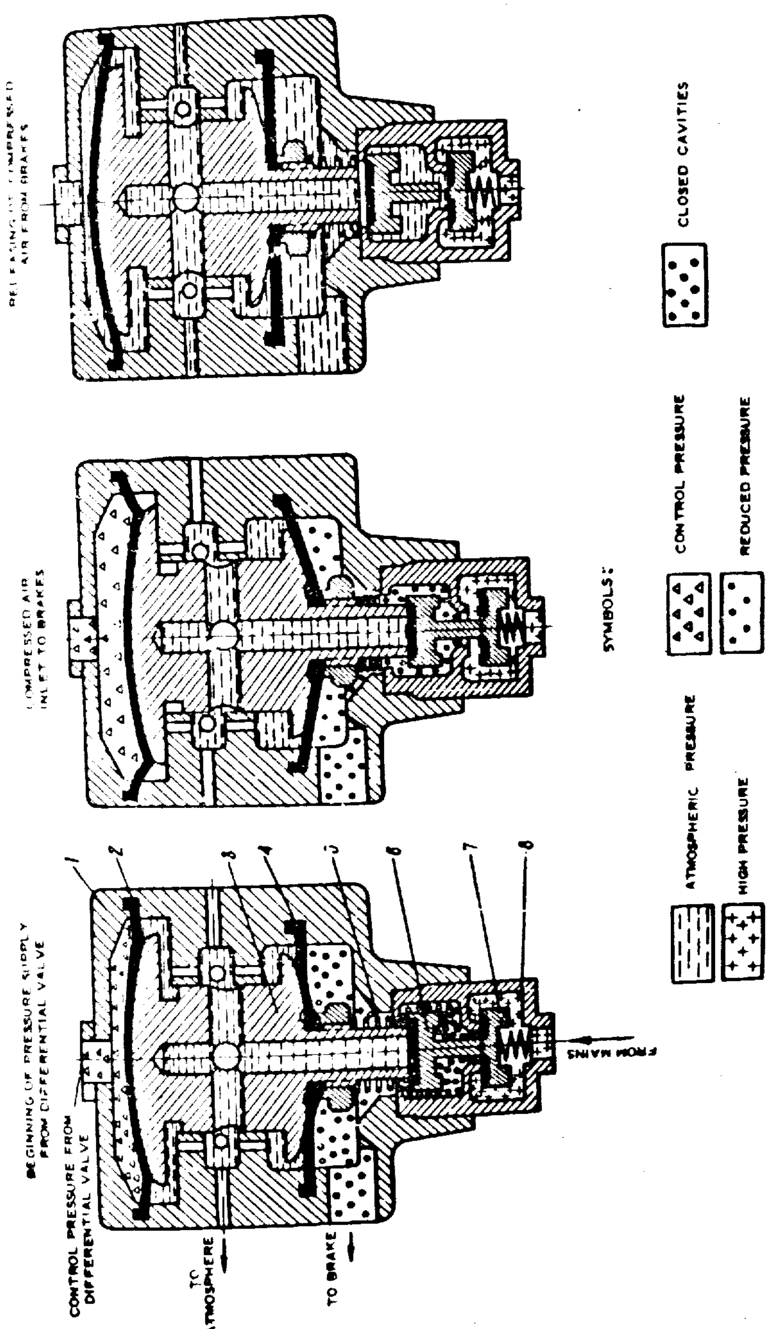

FIG.108. YTI-24-2 PRESSURE AMPLIFIER

1 – body; 2 – diaphragm; 3 – piston; 4 – diaphragm; 5 – spring; 6 – outlet valve; 7 – inlet valve; 8 – guide.

[redacted]

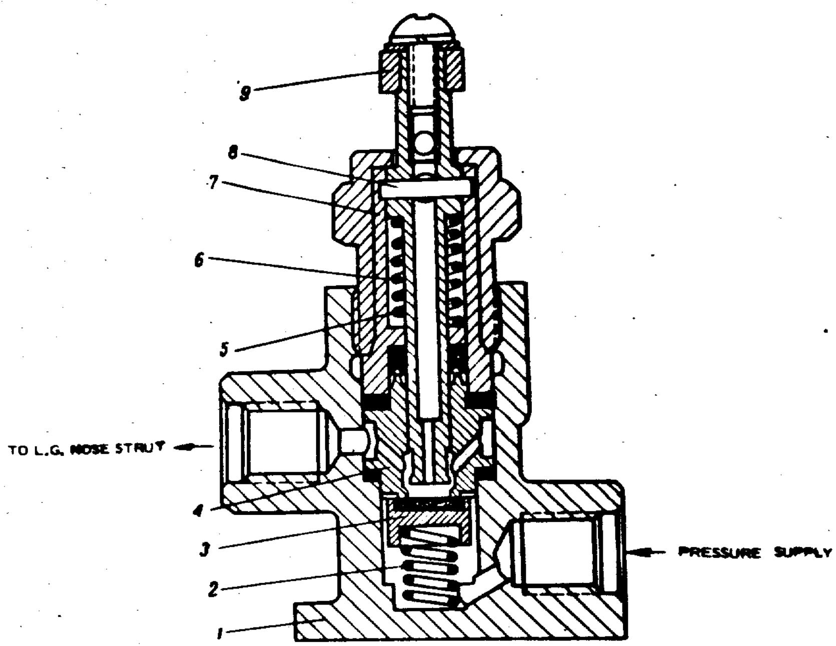

FIG.109. УП-33/1 VALVE FOR SWITCHING L.G. NOSE STRUT BRAKING SYSTEM

1 – body; 2 – spring; 3 – valve; 4 – seat; 5 – retracting spring; 6 – rod; 7 – guide; 8 – pin; 9 – handle.

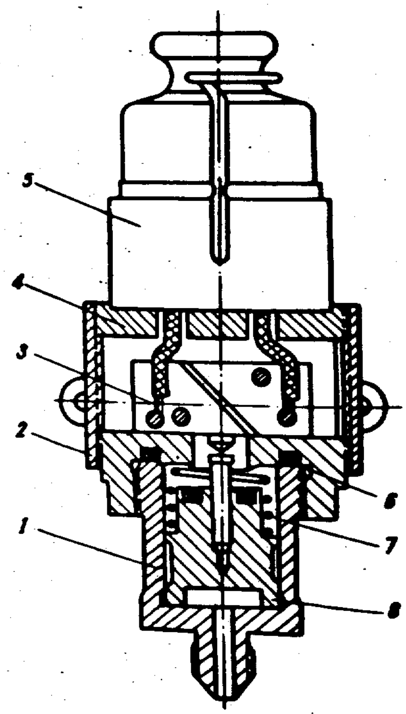

FIG.110. УП-[illegible] SWITCH

1 – connection; 2 – body; 3 – limit switch; 4 – bonnet; 5 – electric connection; 6 – sealing washer; 7 – spring;

By cutting in the valve and depressing the brake lever, the pilot can brake all three wheels; with the valve cut out, the nose wheel brake will not be applied.

The valve consists of body 1, rod 6, valve 3 with spring 2, seat 4, guide 7, and retracting spring 5.

With the valve in the OFF position, the air supplied through the inlet connection does not flow to the outlet connection because valve 3 shuts off the passage port.

When the valve is cut in, the rod turns and travels downward because pin 8 passing in the rod slides along the slant grooves of the guide whose tapered end has a locking recess. Due to this the rod in its extreme position is locked which prevents the valve from spontaneous cutting off when the handle is released.

As the rod travels downward, the inlet valve moves with its rod downward; in this case the rod inner drilling which communicates with the atmosphere is shut off. As the inlet valve travels downward, the nose wheel brake lines get connected.

The nose wheel brake line can be switched off even if there is pressure in the brake system.

When the pin leaves its locking recess, the spring-loaded rod returns to the initial position and the inlet valve lowers to its seat thus disconnecting the nose wheel brake lines and the pressure from the nose wheel brake is released into the atmosphere through the port in the rod.

The nose strut brake valve is mounted in the cockpit. Its control handle is located in the left-hand upper portion of the instrument panel.

УП-22 Switch (Fig.110)

The УП-22 switch (Fig.110) serves to close the electric circuit of the automatic brake release system when there is pressure in the brake system and to open the circuit at zero pressure.

When pressure is supplied to connection 1 of the brake line from the ПУ-7 reducing valve, valve 8 under the influence of the pressure overcomes the tension of spring 7, shifts and closes the electric circuit by limit switch 3.

At zero pressure the valve returns to the initial position acted upon by spring 7, releases the button of the limit switch and the electric circuit opens.

The switch closes the circuit as the pressure rises up to 0.7 kg/cm^2.

The УП-22 switch is located on the cockpit floor near the reducing valve.

УП-53/1-2 Electromagnetic Servovalve (Fig.111)

The electromagnetic servovalve is used in the main wheels automatic brake release system.

The valve freely passes air into the brake chamber if the electric circuit is de-energized and releases pressure from the chamber with simultaneous stopping of air supply from the brake system.

When the valve is in the BRAKED (ЗАТОРМОЖЕНО) position, no current is fed to the coil winding due to which the compressed air flows freely into the brake chamber.

When the coil is energized at the wheel skidding and the pick-ups operate, core 2 overcomes the resistance of spring 4, is pulled up to the seat thus stopping pressure supply to the brakes.

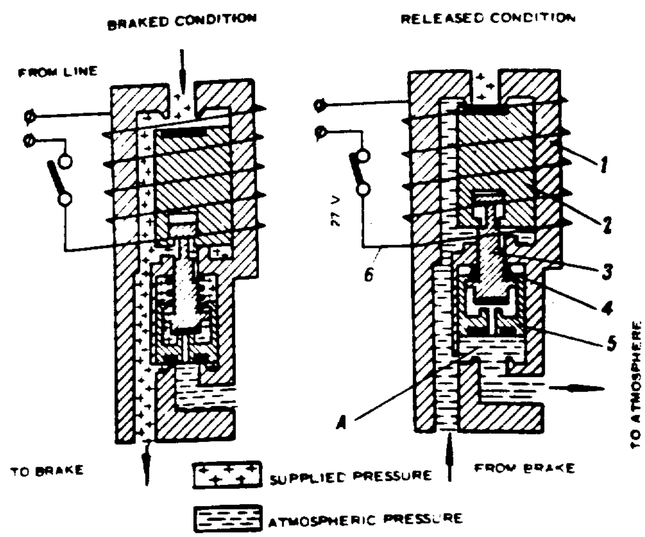

FIG.111. ЭП-53 1-2 ELECTROMAGNETIC SERVOVALVE
1 – body; 2 – core; 3 – servovalve; 4 – spring; 5 – valve; 6 – electromagnetic coil.

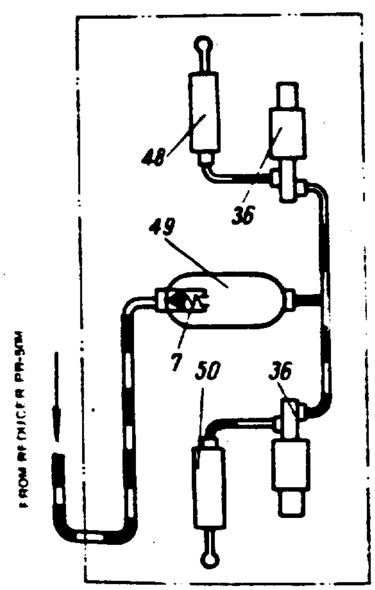

FIG.112. DRAG CHUTE CONTROL SYSTEM. Reference numbers are as in Fig.96.
1 – return valve; 36 – electropneumatic valve ЭПК-6ОМ; 48 – chute dropping cylinder; 49 – air bottle; 50 – drag chute doors opening cylinder.

Simultaneously servovalve 3 with spring 4 opens; the spring serves as a shock absorber for preventing the servovalve rubber from damage when it strikes the seat of valve 5.

In this case the air from chamber A is discharged into the atmosphere thereby releasing valve 5 from back pressure. Under the action of pressure in the brakes this valve opens and discharges air from the brakes into the atmosphere through two ports.

After elimination of skidding, the spring-loaded core, being de-energized, returns to the initial position, and the servovalve sinks to its seat. Then valve 5 shuts off the outlet port and the brake chamber cavity again communicates with the brake line.

The servovalves of the L.G. main wheels are installed on the wing spars in the main wheel strut wells, and the nose strut servovalve is mounted in the lower part of the nose strut well near frame No.6.

5. Drag Chute Control System (Fig.112)

Opening of the drag chute container doors and dropping of the chute are performed at the pilot's will by supplying pressure to the respective cylinders through 695000M electropneumatic valves 36.

The air from the main system through the PB-50M reducer and return valve 7 fills service bottle 49, of 1.3 lit. capacity.

When the respective control buttons are depressed, 695000M pneumatic valve 36 operates and the pressure is delivered to the door opening and drag chute dropping cylinders. Button DROPPING (СБРОС) is located in the horizontal part of the left-hand console near board M3-1 and is protected with a cap. Button RELEASE (ВЫПУСК) is located in the vertical part of the left-hand console.

6. Units of Drag Chute Control System

695000M Electropneumatic Valve (Fig.113)

The 695000M electropneumatic valve is intended for supplying pressure to the cylinders when the electromagnet coil is energized, and for releasing the supplied pressure when the electromagnet is de-energized with simultaneous shutting-off of the supply pressure duct from the air system.

The valve and the air bottle are installed in the compartment for cylindrical hydraulic accumulators arranged between frames Nos 31 and 33, above.

The valve consists of body 3 accommodating inlet valve 2, outlet valve 5, electromagnet 6 with armature 7.

If the coil is de-energized, the inlet valve is in the closed position under the action of spring 1 and air pressure, since the space of the input connection and that below the valve communicate.

Tappet 4, located on the inlet valve, opens the outlet valve and connects outlet connection Б with the atmosphere through port B.

When the coil is energized, the armature shifts the outlet valve till it contacts the seat. As a result, outlet connection Б will be disconnected from the atmosphere.

At the same time tappet 4 with valve 2 shifts downward by means of spring damper 8 which prevents quick wear of the inlet valve rubber packing. In this case the cavity of connection A communicates with the cavity of connection Б and compressed air flows to the cylinder.

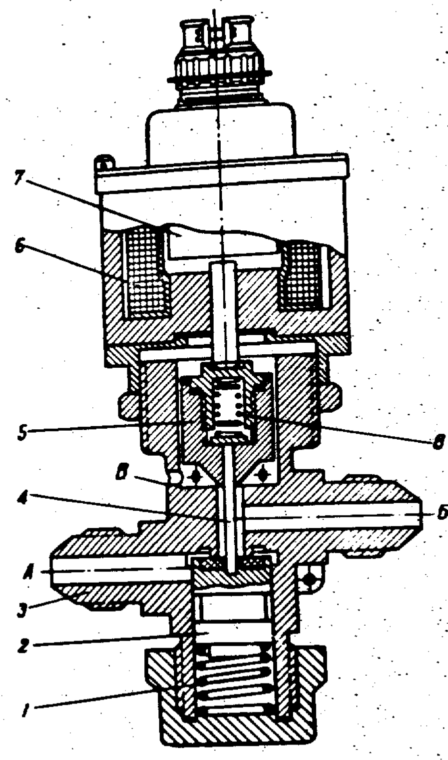

FIG.113. 695000M ELECTROPNEUMATIC VALVE
1 – spring; 2 – inlet valve; 3 – body; 4 – tappet; 5 – outlet valve; 6 – electromagnet; 7 – armature; 8 – spring.

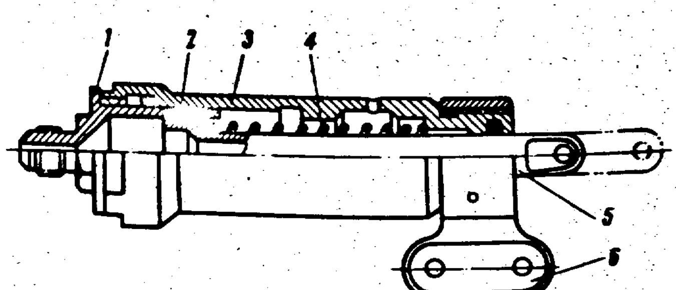

FIG.114. DRAG CHUTE DROPPING CYLINDER
1 – cover; 2 – sealing ring; 3 – body; 4 – retracting spring; 5 – rod; 6 – bracket.

As the coil is de-energized, the compressed spring shifts the inlet valve to its seat. As a result, the line is shut off, and the compressed air is released from the cylinder through the outlet valve.

Drag Chute Dropping Cylinder (Fig.114)

The cylinder consists of body 3 and cover 1. Installed inside of the body are rod 5 and retracting spring 4.

The rod is pressurized on the piston by rubber ring 2. As the pressure is supplied, the rod moves for release, unlocking the chute.

When pressure is released, the rod returns to the initial position by the retracting spring. The cylinder is fixed in bracket 6. The cavity accommodating the spring communicates with the atmosphere through the port in the body.

The door opening cylinder is of similar construction.

7. Emergency Air System

The emergency air system is designed for L.G. emergency extension and for emergency wheel braking at landing in case the main hydraulic or the main air system fails to operate, respectively.

Two air bottles serve as pressure sources.

The bottles are charged from the line, which feeds the main air system through the charging valve.

Compressed air in the emergency wheel brake system is fed to УП-25/2 reducing valve (through PB-50M reducer 16) and to the L.G. emergency extension valve.

To extend the L.G. on emergency if the pressure in the main hydraulic system drops, open the valve located on the right-hand console in the cockpit (the valve has the L.G. EMERG. EXTENSION (АВАР. ВЫПУСК) inscription on the handwheel).

8. L.G. Main Wheel Emergency Braking

(Fig.115)

The L.G. main wheel emergency braking is resorted to in case the brake system cable breaks, at zero pressure or if the main wheel braking system units fail to operate.

The emergency braking system is supplied from the emergency system bottles and comprises PB-50M reducer 16, reducing pressure from 110-130 kg/cm^2 down to 50 kg/cm^2, УП-25/2 reducing valve 17 and two 563600M emergency switches 40.

To perform emergency braking of the wheels, it is necessary to open the reducing valve located in the left-hand part of the instrument panel in the cockpit by pulling the handle inscribed EMERGENCY BRAKING (АВАР. ТОРМОЖЕНИЕ) having broken the locking wire. In this case the air from the emergency bottles through the reducer and reducing valve will flow to the emergency switches and, through them, to the wheel brakes. As the handle is smoothly turned, the pressure rises gradually from 0 to 17.5 $\pm$0.5 kg/cm^2.

To release the wheels, the reducing valve should be closed by placing the EMERGENCY BRAKING handle in the initial position.

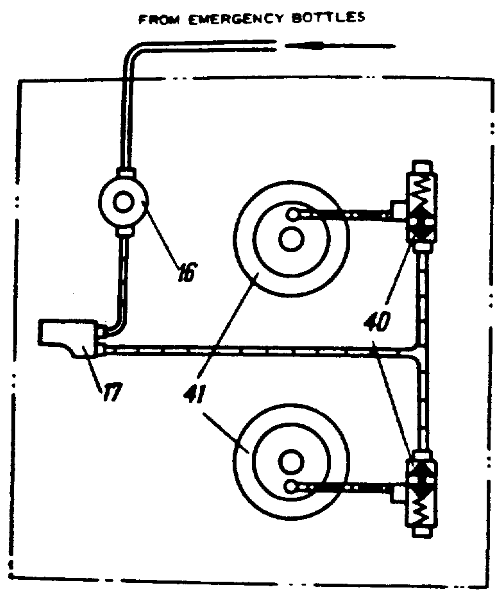

FIG.115. EMERGENCY BRAKING SYSTEM (Reference numbers are as in Fig.96)
16 – emergency braking reducer; 17 – reducing valve ЗТ-25 2; 40 – emergency switch; 41 – main strut wheel KT-92.

9. Emergency System Units

РВ-50М Reducer

The operating principle of the РВ-50М reducer is described in Section "System Charging Line Units" of the given Chapter.

УП-25/2 Reducing Valve (Fig.116)

The УП-25/2 reducing valve is designed to create a reduced pressure in the emergency brake system. In its operation it is similar to the ПУ-7 reducing valve. The valve has two cavities: upper and lower. The upper cavity associates with the atmosphere through ports in tappet 1 and also with the brake line. The lower cavity associates with the pressure line of 50 kg/cm^2. When pressing the tappet, the valve compresses spring 5 and forces the piston seat toward outlet valve 7. In this case the upper cavity is shut off from the atmosphere. Further movement of diaphragm piston 6 downwards opens inlet valve 11 and gives way to the flow of compressed air from the lower cavity into the upper cavity and the brake line. The air continues flowing till its pressure acting on piston 6 from below compresses spring 5 by a distance required to close input valve 11. At this moment further delivery of air into the brake line stops. The reduced pressure value depends on the depth of valve rod immersion. With the valve fully open, the pressure rises up to 18 kg/cm^2. When the effort is removed from the tappet, the air from the brake line gets released into the atmosphere.

563600 Emergency Switch (Fig.117)

The emergency switches are installed on the main wheel struts, one on each side.

The emergency switch is designed to supply compressed air from the emergency system to the brake chambers with simultaneous closing of the line supplying air from the main brake system.

The valve consists of body 1, shuttle lock 2, connection 3 and spring 4.

The air from the emergency system is supplied to the A connection. In this case shuttle lock 2 which prior to this rested on the body seat is sharply thrown to the right and having overcome the resistance of the retracting spring sinks to the Б connection seat, thus shutting off the main brake line duct. Due to this the air from the emergency system starts flowing to the B connection which is jointed with the brake chamber. When the wheel brakes are released, the pressure in the brake line drops and the retracting spring shifts the shuttle lock to the left, connecting the brake chamber with the main brake line again.

The duct is sealed in both positions by the face rubber packing located on the lock end faces.

10. Landing Gear Emergency Extension (Fig.118)

The landing gear is extended on emergency in case the main hydraulic system fails to operate.

The L.G. emergency extension system comprises emergency extension valve 10, vent valve 11, two cylinders 13 for releasing the L.G. main strut up-locks and two emergency valves 14, mounted in the L.G. doors opening system, and valve 7.

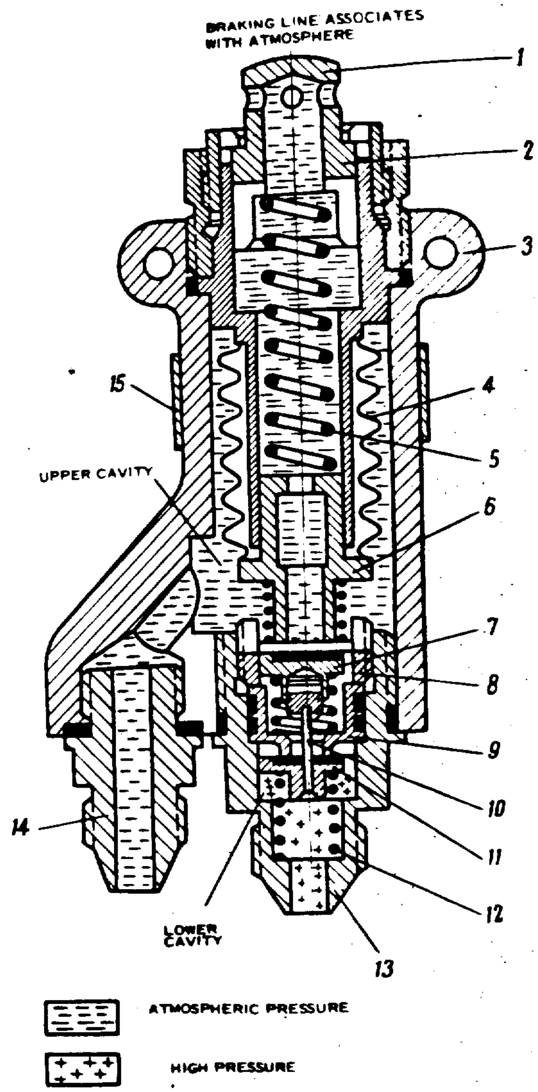

FIG.116. УП-25/2 REDUCING VALVE
1 – tappet; 2 – tube; 3 – body; 4 – diaphragm; 5 – spring; 6 – piston; 7 – outlet valve; 8 – threaded bushing; 9 – tube; 10 – needle; 11 – inlet valve; 2 – spring; 13 – inlet connection; 14 – outlet connection, 15 – name-plate.

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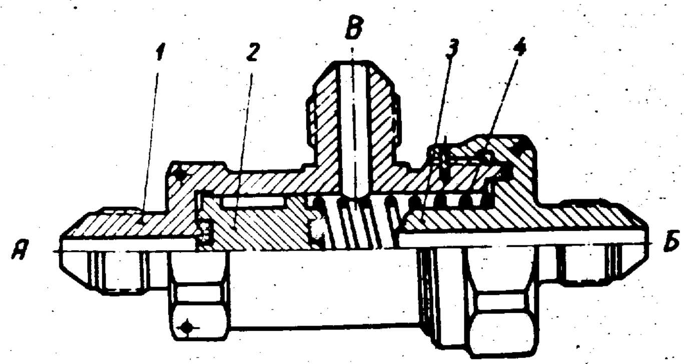


FIG.117. 563600 EMERGENCY SWITCH
1 – body; 2 – shuttle lock; 3 – connection; 4 – spring.

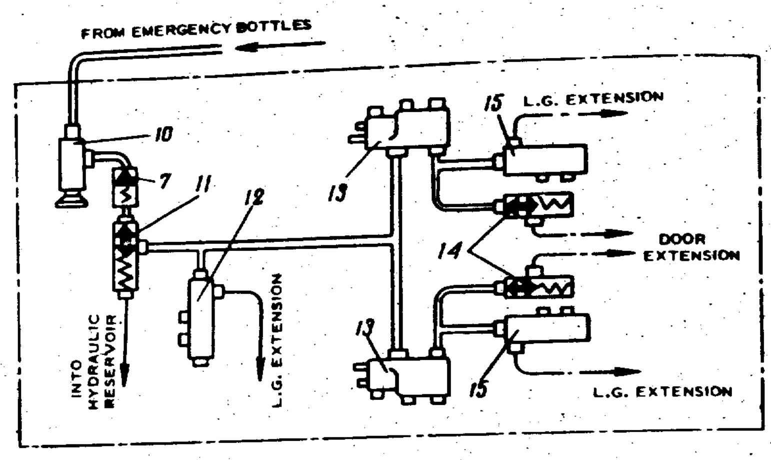


FIG.118. LANDING GEAR EMERGENCY EXTENSION (Reference numbers are as in Fig.96)

7 – return valve; 10 – L.G. emergency extension valve; 11 – vent valve; 12 – L.G. nose strut hydraulic lock; 13 – L.G. main strut up-lock; 14 – emergency valve; 15 – main strut hydraulic lock.

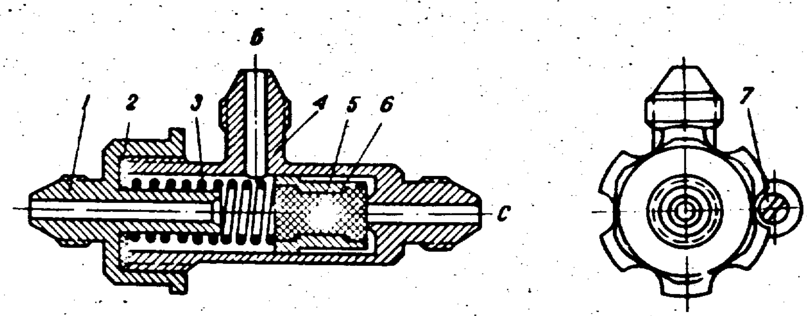


FIG.119. VENT VALVE

1 – cover, 2 – gasket; 3 – spring; 4 – body; 5 – valve packing; 6 – valve; 7 – screw.

During the L.G. emergency extension the mechanical L.G. locks are opened by the compressed air delivered to the L.G. struts up-lock cylinder.

When the L.G. emergency extension valve located in the cockpit on the right-hand console is opened, the compressed air from the emergency bottles at a pressure of 110 - 130 kg/cm^2 is supplied through the valve and the vent valve to the cylinders of the L.G. suspension locks, which are interconnected mechanically with the L.G. wheel door mechanical locks.

The L.G. up-locks and the wheel door locks opened, the compressed air through the emergency valves is supplied to open the wheel doors and through the hydrolocks to extend the L.G. wheels. To extend the L.G. nose strut, the compressed air is supplied directly to the hydrolock and through it to the nose strut actuating cylinder.

The L.G. extended, it is necessary to release air from the L.G. actuating cylinders by disconnecting the pipe between the cylinders and hydrolocks.

11. Units of L.G. Emergency Extension System

Vent Valve (Fig.119)

The vent valve construction is identical to that of the emergency switch.

When pressure is supplied, the compressed air shifts the shuttle lock in such a way, that the extension lines which were previously connected to the hydraulic reservoir through pipelines, are connected now to the line which runs to the emergency extension valve and supplies air for the L.G. emergency extension.

After the L.G. is extended, the compressed air is released from the L.G. actuating cylinders, the shuttle lock returns to the initial position and the L.G. emergency extension lines communicate again with the hydraulic reservoir; this ensures drainage of the fluid which otherwise may leak into the air system in case of improper airtightness of valves, hydrolocks and emergency valves.

L.G. Main Struts Up-Lock Cylinder (Fig.120)

The L.G. main struts up-lock cylinder is comprised of two units: L.G. up-lock cylinder and L.G. emergency releasing cylinder. The two units are intended to open the main struts up-lock and the L.G. wheel doors locks hydraulically (or by means of air in case the hydraulic system fails); however, the units are designed to operate independently.

The construction and principle of operation of the first unit are described in Section "L.G. Control Units". The present Section deals only with the construction and the operating principle of the second unit, i.e. the emergency releasing cylinder. Both the units are mounted in a common housing.

The emergency releasing cylinder consists of body 2 which houses rod 5 with retracting spring 4, valve 8 sliding along guide 6 of the valve rod, cover 9 fixed with a bolt, and spring 7.

The cylinder has two holes for its bolting to the wing structure.

The cylinder is provided with two connections: one associating the pressure inlet line with the cylinder inner cavity and the other running to the L.G. main strut hydrolock and wheel doors emergency valve.

When the air is supplied for L.G. extension, the pressure is delivered to the lock cylinder. This makes rod 5 shift and the retracting spring be compressed. After the rod has travelled 14 mm which is quite enough to unlock the struts, it

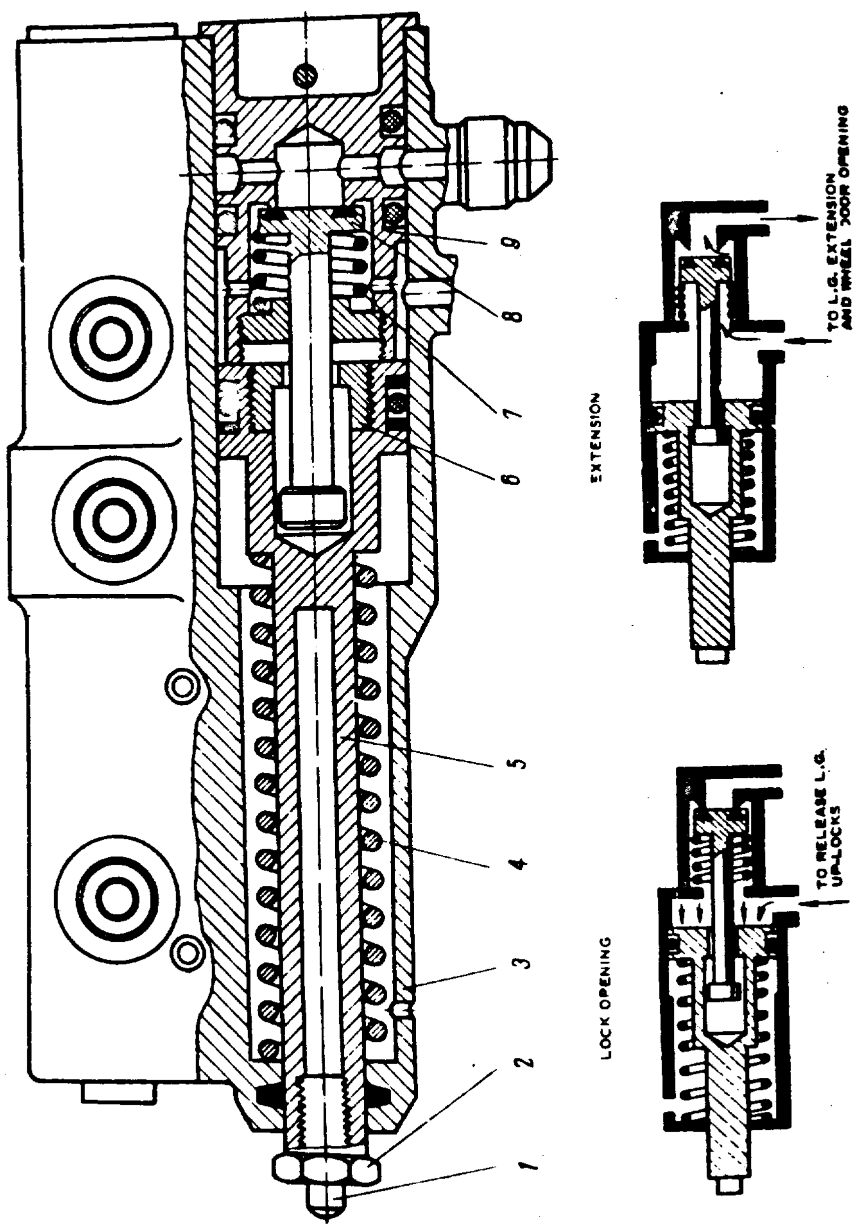


FIG.120. L.G. MAIN STRUT UP-LOCK CYLINDER

1 - adjusting bolt; 2 - locknut; 3 - body; 4 - returning spring; 5 - rod; 6 - guide; 7 - spring; 8 - valve; 9 - cover.

begins shifting the valve (up to this moment the valve has been pressed to the seat by air and spring 7). Valve 8 leaves the seat and the air passes through the connection to the hydrolock and emergency valve and makes the door open and the strut extend, the both processes going on at the same time. When the pressure is released, the rod is returned by the spring to the initial position and the valve gets into the seat. The 14-mm rod travel is adjusted till the valve is meshed (before the valve starts moving) by means of the nut in the rod piston; the setting adjustment is carried out by means of bolt 1.

Emergency Valve (Fig.121)

Two emergency valves are installed in the L.G. emergency extension line.

The emergency valves serve to separate the hydraulic system from the L.G. emergency extension system when the latter operates, and vice versa, to separate the emergency system from the hydraulic system when the hydraulic system operates normally.

Each valve has three connections, through one of which the valve is connected to the L.G. emergency extension air system.

The valve consists of body 1, cover 4, piston 2 and spring 3.

Under the action of the spring and fluid pressure the piston shuts off the compressed air supply channel, thereby preventing penetration of the fluid into the emergency air system.

During operation of the emergency air system the air-pressed piston overcomes the tension of spring 3, reaches the butt-end of the fluid inlet connection, shuts it off giving the way to the air into the L.G. extension line.

To hermetically seal the air system, the piston has a tapered protrusion; from the side of the hydraulic system it has a rubber gasket which is tightly pressed to the sharp end of the seat on the inlet connection to prevent air penetration into the faulty hydraulic system.

12. Canopy Pressurization and Control System (Fig.96)

The canopy air system is subdivided into the service and emergency systems.

The service air system is intended to pressurize and lift the canopy. It comprises canopy lifting cylinders 20, pressurization hose 18, canopy control valve 19, air valve 23, PB-1,5 reducer 24 and return valve 7.

The emergency air system is used to jettison the canopy on emergency. It comprises return valve 7 separating the emergency air system from the system with a pressure of 130 kg/cm^2, diaphragm valve 27, filter 22, air cylinder 21 used to open the time delay lock during emergency jettisoning of the canopy, bottle 25 to measure pressure and connection 26 to release air.

A detailed description of the operation of the system and its units is given in Chapter VIII.

13. De-Icing System (Fig.96)

In the canopy de-icing system the air from the main system under a pressure of 50 kg/cm^2 is delivered through ПУ-7 reducing valve 31 with a pressure of 3 kg/cm^2 and the return valve to alcohol tank 30. From the alcohol tank the alcohol is pressed through the sprayer onto the surface of the windshield.

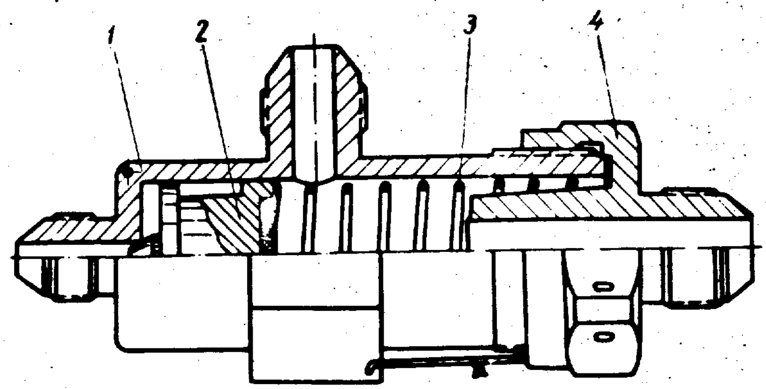


FIG.121. EMERGENCY VALVE
1 – body; 2 – piston; 3 – spring; 4 – cover.

The construction and operating principle of the reducing valve and return valve are given above.

A detailed description of the de-icing system operation is presented in Chapter VIII.

14. Compartments Cooling System (Fig.96)

The pressurized fuselage compartments accommodating radio equipment are cooled by the air delivered through the air intake due to the ram pressure.

The valves are opened and closed by ЭК-69 electropneumatic valve 34. At a speed of flight below number M=1.35 the pneumatic valves are open and the air passes through the compartments. At a speed with M=1.35 or more the pneumatic valves close and stop air bleed from the compartments.

Air throttle 33 serves to exclude shocks in the operation of pneumatic valve 32.

15. Fuel System Shut-Off Valve Control

(Fig.96)

The shut-off valve is closed in flight by means of the actuating cylinder to which the air at 50 kg/cm^2 is delivered from the air system through the 695000M pneumatic valve.

When switching on the electropneumatic valve, the cylinder operates and closes the valve.

HYDRAULIC SYSTEM

General

The aircraft hydraulic system (Fig.122) consists of two independent systems: the booster and the main systems.

The booster system is intended for feeding the control boosters: two-chamber booster, type БУ-51МС and the aileron boosters.

The functions of the main system are the following:

(a) retraction and extension of the engine intake cone;
(b) control of the anti-surge shutters;
(c) retraction and extension of the wing flaps;
(d) retraction and extension of the landing gear;
(e) control of the air brakes;
(f) control of the afterburner flaps;
(g) feeding of booster БУ-51МС second chamber;
(h) automatic wheel braking during retraction of the landing gear.

Simultaneously the main system serves as a duplicating system to operate aileron boosters БУ-45А.

In each system НП34-1Т variable displacement pumps 28 and 60 serve as sources of hydraulic energy.

Mineral oil АМГ-10 is the working fluid of the system. The hydraulic reservoir is divided into two compartments: booster 62 and main 63. The reservoir is provided with a pressurization system which is fed with compressed air supplied from the 6th stage of the engine compressor.

The system employs the closed-type charging so that the fluid supplied from the charging arrangement via the charging valves is delivered at a pressure of 3 to 4 kg/cm^2.

At the pump outlets the fluid, before it enters the units of the system, passes through filters 20 provided with fine filtering elements.

The pressure in the system is measured by means of two-pointer remote-reading electric pressure gauge 39, type 2ЗДИМ-250А.

Pressure regulators built into the pumps are used to maintain the desired pressure in the two hydraulic sys[illegible] Pressure rise in excess of the required value indicated above is limited b[illegible]ty valves 21.

In the case of sharp increases in fluid consumption, the reserve fluid of the hydraulic accumulator is given off to supplement the quantity of fluid supplied to the system by the pump. This provides uniform pressure variations in the case of abrupt changes in fluid consumption. Apart from this, the hydraulic accumulator is intended to suppress the pressure fluctuations and absorb the hydraulic shocks.

Each of the two systems is provided with one spherical 22 and one cylindrical 48 hydraulic accumulator.

The spherical hydraulic accumulators of any of the two systems supply reserve fluid to the aileron and stabilizer boosters only.

For this purpose the spherical accumulator of the main system is separated from the rest of the system by a check valve. (In the main system the line through which the boosters are fed is also employed to control the engine nozzle flaps.)

Therefore, after the engine is stopped or a ground hydraulic pump is cut off, the pressure in the systems of the landing gear, air brakes, wing flaps, cone and anti-surge shutters is not indicated by the cockpit pressure gauge. In this case the pressure in the main system can be released only through the stabilizer booster by turning the aircraft control stick.

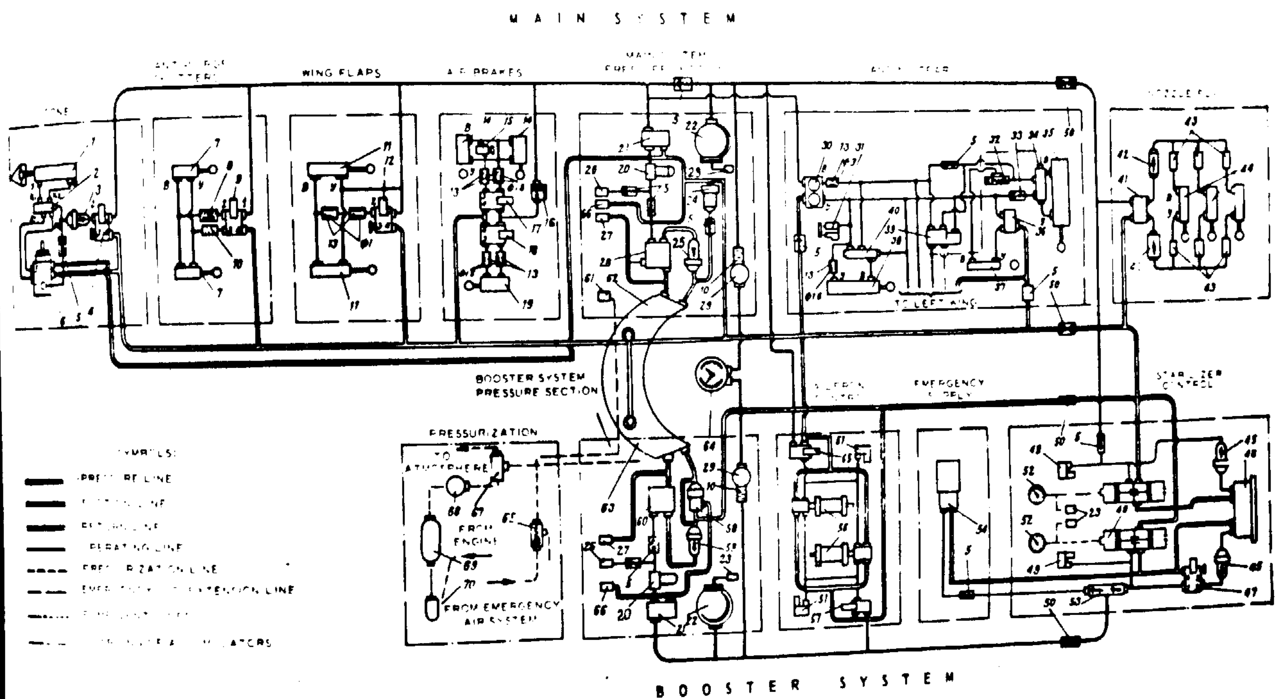
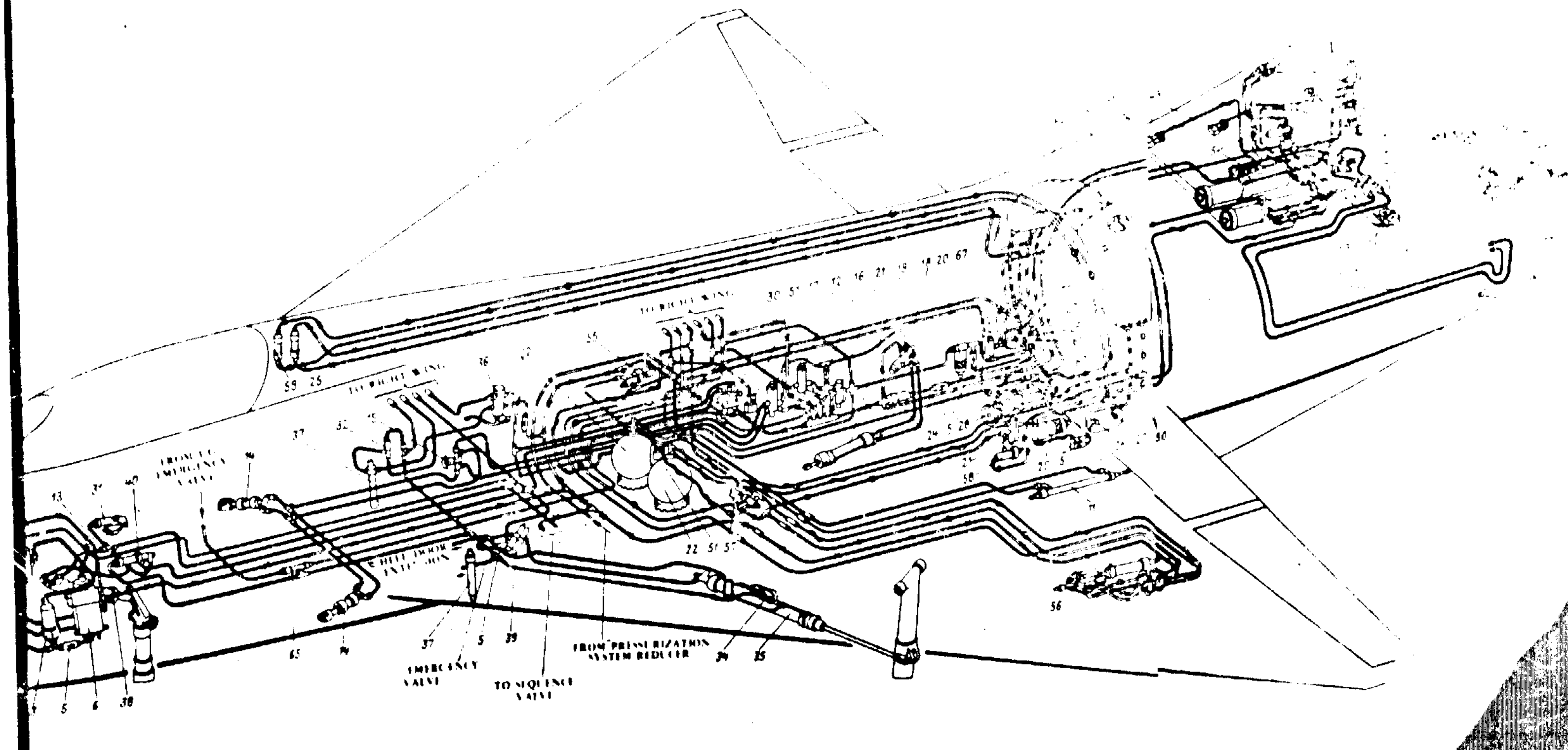


FIG.122. KEY DIAGRAM OF HYDRAULIC SYSTEM

1 – cone cylinder; [illegible] – cone cylinder hydrolock; 3 – [illegible] filter; 4 – ГА-184У cone valve; 5 – check valve; [illegible] control unit; 7 – anti-surge shutters cylinder; 8 – differential throttle; 9 – ГА-124У flaps valve; 10 – throttle; 11 – wing flaps cylinder; 12 – wing flaps valve [illegible]; 13 – throttle; 14 – side air brake cylinder; 15 – cross-feed valve; 16 – check valve with thermovalve; 17 – side air brake valve ГА-184У; 18 – ventral air brake valve ГА-184У; 19 – ventral air brake cylinder; 20 – [illegible] fine filter; 21 – ГА-186М safety valve; 22 – spherical hydraulic accumulator; 23 – charging valve 642500; 24 – main system return line fine filter; 25 – main pump circulating line filter 11ФГ-4С; 26 – aircraft valve (pressure); 27 – aircraft valve (suction); 28 – main system pump НШ14-1Т; 29 – pressure gauge [illegible]; 30 – L.G. valve ГА-142 [illegible]; 31 – automatic brake cylinder; 32 – emergency pickup [illegible]; 33 – one-way throttle; 34 – L.G. main strut actuating cylinder hydrolock; 35 – L.G. valve; 36 – sequence valve; 37 – L.G. main strut wheel door cylinder; 38 – L.G. main strut actuating cylinder; 39 – L.G. main strut up-lock cylinder; 40 – L.G. nose strut actuating cylinder hydrolock; 41 – nozzle flaps valve ГА-[illegible]; 42 – [illegible] metering unit; 43 – synchronizing valves; 44 – afterburner flaps ring cylinders; 45 – 11ГФ4С fine filter; 46 – stabilizer booster БУ-51МС; 47 – ГА-184У valve for disconnecting БУ-51МС booster from booster system; 48 – cylindrical hydraulic accumulator; 49 – ГА-135Т pressure-sensitive relay; 50 – disconnect valve; 51 – pressure-sensitive relay ГА-135 for pressure interlocking of autopilot КАП-2; 52 – cylindrical accumulator air pressure gauge МН-250М; 53 – dual check valve; 54 – НШ-2Т emergency pumping unit; 55 – ГА-100 valve for disconnecting БУ-45А aileron booster; 56 – БУ-45А aileron booster; 57 – ГА-100 valve for disconnecting booster from main system; 58 – booster system return line gauge filter; БУ-45А booster from booster system; 59 – booster pump circulating line filter 11ГФ4С; 60 – booster system pump НШ34-1Т; 61 – release valve; 62 – hydraulic reservoir main system compartment; 63 – hydraulic reservoir booster system compartment; 64 – УА2-250А pressure gauge indicator; 65 – vent valve; 66 – filling valve; 67 – pressurization valve; 68 – reducer 6826004; 69 – pressurization unit; 70 – [illegible]



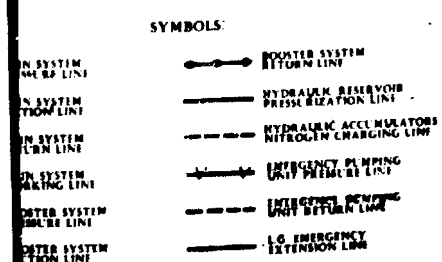


FIG.123. HYDRAULIC SYSTEM ARRANGEMENT DIAGRAM
(For keys to reference numbers see Fig.122)

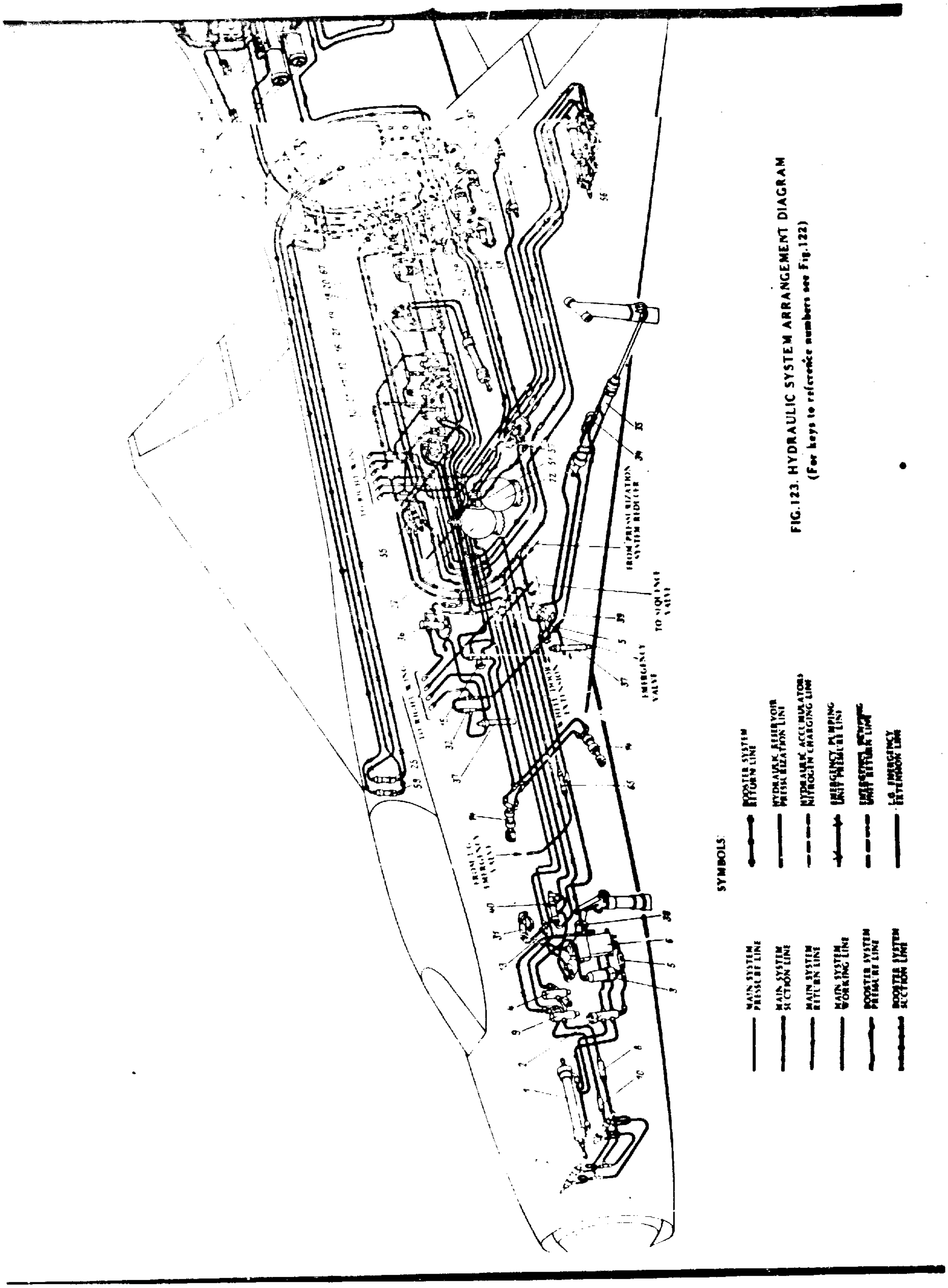


FIG.123. HYDRAULIC SYSTEM ARRANGEMENT DIAGRAM
(For keys to reference numbers see Fig.122)

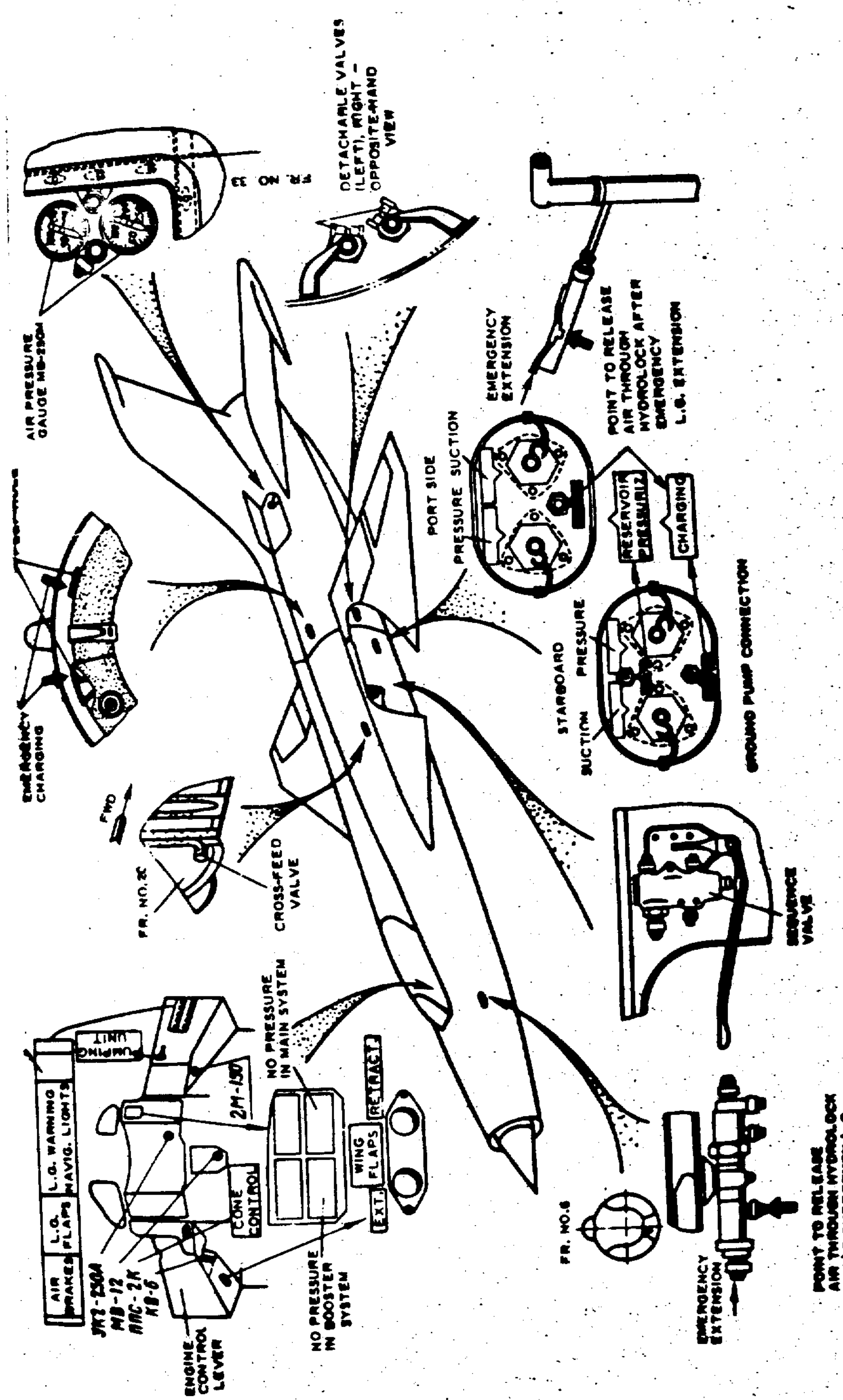


FIG.174. DIAGRAM OF HYDRAULIC SYSTEM OPERATING POINTS

The cylindrical hydraulic accumulators can discharge into the stabilizer booster alone. To effect this, they are separated from the systems by check valves.

The units of the systems are controlled by means of electromagnetic valves which in turn are controlled remotely from the cockpit.

When the booster and main systems operate normally, the stabilizer booster is fed simultaneously from both systems whereas the aileron boosters are fed from the booster system only.

In case the booster system fails, the aileron boosters are changed over to the main system supply, the stabilizer booster being fed from one chamber.

To ensure landing in case the engine rotor is jammed or when the pumps of the booster and main systems fail, the booster system is provided with НП-27Т emergency pumping unit 54 driven by the electromotor powered by the aircraft mains.

The two systems are provided with a pressure drop light warning system. The electrical circuit of each lamp is cut in by pressure-sensitive relay 51 when the pressure in the system drops.

Apart from the pressure drop warning system relay 51 simultaneously switches on pumping unit НП-27Т.

To ensure cleanliness of the working fluid, the system is provided with filters distributed as follows (Fig.125):

filter ФГ11/1С is installed at the pump outlet;
filter 11ГФ-4С is installed at the inlet of the stabilizer booster;
a gauze filter is installed in the return line to the reservoir;
filter 11ГФ-4С is installed in the return line from the pump.

The filters installed in the main system are distributed as follows:

filter ФГ11/1С is installed at the pump outlet;
filter 11ГФ-4С is installed at the inlet of the stabilizer booster;
a fine filter is installed in the return line to the reservoir;
filter 11ГФ-4С is installed in the return line from the pump;
filter 11ГФ-4Б-1 is installed in the pressure line before the АУ-35-1 unit of the cone system.

To clean the compressed air delivered to the reservoir pressurization system from the compressor, a silk filter is installed at the hydraulic reservoir pressurization unit.

Filters are also fitted at the inlets to, and inside of, boosters БУ-51МС and БУ-45А.

In order to reduce the pressure of the return fluid, the main system is provided with orifice plates installed at the outputs of the L.G. control valves, air brake valves and wing flap valves.

Apart from this, orifice plates are installed in the system controlling the wing flaps and anti-surge flaps so as to achieve the desirable speed of operation of the units.

To operate the systems on the ground, there are inboard connections to connect the ground hydraulic installation and a connection to couple the hydraulic reservoir pressurization system.

High-pressure lines are made of stainless steel pipes, grade Х18Н10Т, and return lines are made of pipes, grade АМГМ.

The key and arrangement diagrams are shown in Figs 122 and 123.

<u>Basic Technical Data of Hydraulic System</u>

1. Working fluid .... mineral oil АМГ-10 (State Standard ГОСТ 6794-53)

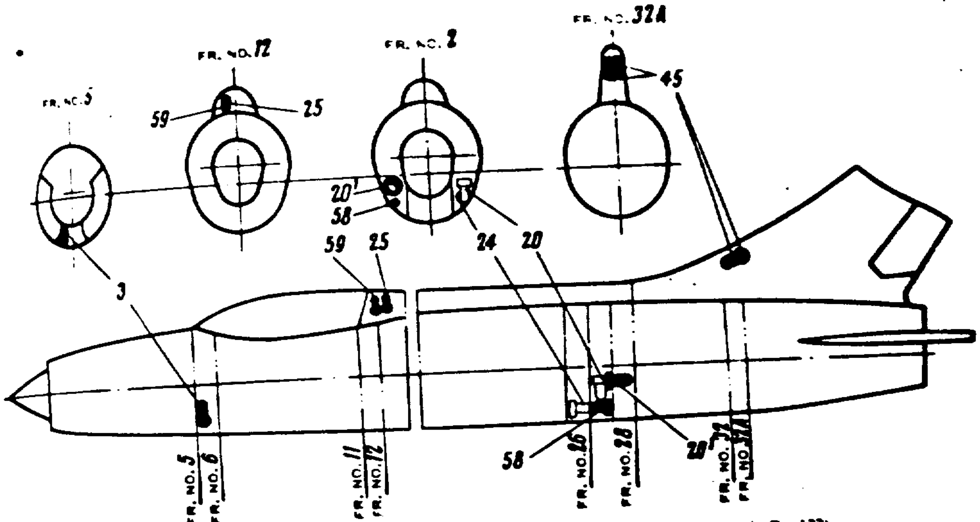


FIG.125. FILTERS DISTRIBUTION DIAGRAM(Reference numbers are as in Fig.122)
3 – cone filter 11ГФ-4Б-1. 20 – main system pressure line filter ФГ-11 1С; 21 – booster system pressure line filter ФГ-11 1С; 24 – main system return line fine filter; 25 – main pump circulating line filter 11ГФ4С; 45 – stabilizer booster pressure line filters 11ГФ4С; 58 – booster system return line gauze filter; 59 – booster system circulating line filter 11ГФ4С.

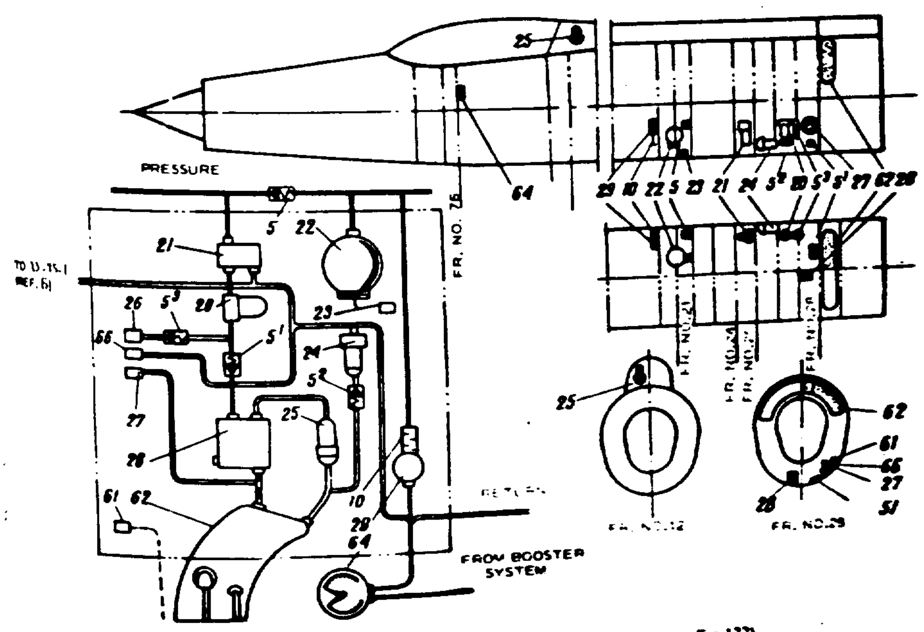


FIG.126. PRESSURE SECTION (Reference numbers are as in Fig.122)
5 – check valve. 10 – pressure gauge damper. 20 – ФГ-11 1С fine filter; 21 – ГА-195М safety valve. 22 – spherical hydraulic accumulator. 23 – filling valve 642500. 24 – main system return line fine filter. 25 – main pump circulating line filter 11ГФ4С. 26 – aircraft valve (pressure). 27 – aircraft valve (suction). 28 – НП34-1Т pump. 29 – [illegible] pressure gauge pick-up. 62 – hydraulic reservoir main system compartment. 66 – filling valve.

SECRET

2. Total volume of fluid filled in the two systems ... 36 lit.
3. Full capacity of main system hydraulic reservoir .. 10.5 lit.
4. Full capacity of booster system compartment in hydraulic reservoir .... 7.2 +8.0 lit.
5. Volume of mixture filled into reservoir for each system .... 6.5 lit.
6. Pressurization value in hydraulic reservoir ...... 1.7 to 2.6 kg/cm^2
7. Safety valve of pressurization system is adjusted to .... 2.8 $\pm$0.3 kg/cm^2
8. Maximum working pressure at zero pump capacity ... 210_{-12} kg/cm^2
9. Maximum pump capacity at a pressure of 180 kg/cm^2:

at 4000 r.p.m.	at the initial stage of operation ..	not less than 35 lit/min.
	at the end of the guaranteed service life	not less than 25 lit/min.
at 500 r.p.m.	at the initial stage of operation ..	not less than 4 lit/min.
	at the end of the guaranteed service life	not less than 2.5 lit/min.

10. Safety valve ГА-186М is adjusted to .... 240 +5 kg/cm^2
11. Charging pressure in hydraulic accumulators .... 50 +5 kg/cm^2
12. Volume of fluid filling accumulator cavities at a pressure of 210 kg/cm^2 in the system:
    spherical accumulator .... 1.15 lit.
    cylindrical accumulator .... 0.83 lit.
13. Thermovalve of air brake cylinders is adjusted to .... 25 $\pm$5 kg/cm^2
14. Cone hydrolock opens and closes at a pressure within .... 70 to 35 kg/cm^2
15. Thermovalve of L.G. hydrolock opens at a pressure of .... 275^{+15}_{-5} kg/cm^2
16. Pressure sensitive relay ГА-135/32 provides:
    cutting-in of warning system and pumping unit at a pressure of .... 165^{+10}_{-5} kg/cm^2
    cutting-off of warning system and pumping unit at a pressure of .... 195 kg/cm^2
    the difference in cutting-in and cutting-off pressures must be within .... 12 kg/cm^2
17. Maximum capacity of emergency pumping unit:
    at the initial stage of operation .... not less than 19 lit/min.
    at the end of the guaranteed service life ..... not less than 16 lit/min.

I. MAIN HYDRAULIC SYSTEM

1. Pressure Section of Main System (Fig.126)

The pressure in the main hydraulic system is built up by variable-displacement piston-type pump НП34-1Т.

The pump is fed from hydraulic reservoir 62 through a suction branch pipe and a hose.

The units installed in the pressure line after the pump are assembled in the following succession: check valve 5, ФГ11/1С fine filter 20, ГА186М safety valve 21, spherical hydraulic accumulator 22, ЭДП50/250 pressure gauge transmitter 29 with the damper.

When the engine is operated, the pump delivers the fluid into the system to build up a pressure in it. As the fluid passes through the check valve which allows the flow from the pump in one direction only, the fluid is supplied to filter ФГ11/1С.

After filtration the fluid is fed to the following units:

to the hydraulic accumulators so that a reserve of hydraulic energy is provided and the accumulators are charged;

to the ЭДП-50/250 pressure gauge pick-up through the damper suppressing the pressure pulsations;

to the unit control valves;

to the stabilizer booster, and to the aileron boosters (in case the aileron booster valve is cut in);

to the pressure-sensitive relay to switch off the pressure drop warning lamp.

Thus, the system is constantly ready for operation since the pressure is uninterruptedly applied to the system valves and to the control boosters.

When the maximum working pressure is reached, the pump capacity regulator sets the pump to minimum capacity. Due to this, the fluid is caused to by-pass through the pump capacity regulator to return from the high-pressure line to the circulating line. While the fluid is being supplied a long way through the external circulating line, it cools down. Prior to entering the reservoir, the fluid returning through the circulating line is purified by 11Г24С fine filter 25.

The fluid drained into the reservoir in the course of operation of the units is purified by ФГ11/1С fine filter 24. Installed after the filter is check valve 5 which prevents return of the mixture from the reservoir in case return line filter 24 is removed.

The aircraft connections for coupling to the ground installation when checking the system on the ground are distributed as follows:

pressure connection 26 is installed in the pressure line after the check valve of the pump before ФГ11/1С filter 20;

suction connection 27 is installed in the suction line of the aircraft system.

The hydraulic system is filled through filling valve 66 connected to the return system before return filter 24.

When checking any of the hydraulic systems on the ground, care should be taken not to fail to connect the ground pressurisation system of the hydraulic reservoir to aircraft pressurization connection 61.

In the case of a pressure rise in the system up to 240^{+5} kg/cm^2, ГА186М safety valve 21 connects the pressure line to the return line so that a pressure not less than 210_{-12} kg/cm^2 is maintained in the system. If the safety valve admits the entire quantity of fluid delivered by the pump, the pressure in the system can rise as much as 262 kg/cm^2.

2. Pressure Section Units

Hydraulic Reservoir (Fig.127)

The hydraulic reservoir is welded of sheet metal.

The reservoir is divided with sealed diaphragm 5 into the booster compartment and the main system compartment. The design of each of the two compartments is similar.

The fluid filled into the reservoir at 3 to 4 kg/cm^2 is supplied by the charging arrangement through the charging valves. The charging valves are attached to the return line at the inlets of the return filters. Hence, the fluid fed to the reservoir passes through drain connection 8.

To check the level of fluid in the reservoir, there is a peep hole in the filler neck with glass tube 17 fitted in casing 18. Engraved on the casing are two mark lines intended to indicate the normal level of the hydraulic mixture.

When the landing gear is extended and the air brakes, wing flaps, anti-surge shutters and the cone are retracted, the level should be located between the two mark lines.

Each compartment is further divided into two cavities by means of separating diaphragms 7 provided with two valves (one of these, 11, has a weak spring and opens downwards while the other, 1, has a strong spring and opens upwards). The diaphragm is designed to ensure normal operating conditions of the pump during an inverted flight.

During an emergency charging of the reservoir, the pressure exerted by the fluid column on the valve with the weak spring causes the valve to open so that the lower capacity of the reservoir is filled. The air forced out of the cavity is expelled through vent pipe 2.

Incorporated in suction connection 9 is a sleeve through which the fluid can be delivered from the lower cavity of the compartments whatever position the reservoir may take in space. In the case of an inverted flight, the fluid in the lower cavities is retained by the valves and does not therefore pass through the diaphragm into the upper cavity.

When the pressure in the lower cavity rises due to fluid supply from the system, the surplus fluid is released to the upper cavity through the valve with the strong spring. In the upper part vent pipe 2 has a hole of 3 mm. dia. Due to this the quantity of fluid escaping through the pipe from the lower into the upper cavity during an inverted flight is insignificant.

The levels of fluid filled into the compartments are equal with an exception of the case when any of the compartments is over-filled by virtue of overflow of fluid through the aileron booster change-over switches. The two compartments of the reservoir are interconnected through a connecting pipe intended to bring the fluid in the compartments to the same level in case of the overfilling of one of the compartments.

To fill the system in case the charging arrangement is not operated, the emergency connection with plug 14 is employed.

The pressure applied to each compartment through the pipes is delivered from the pressurization system through connections 10.

The reservoir is attached to the brackets and fastened by a flexible clamp secured in the central part of the reservoir.

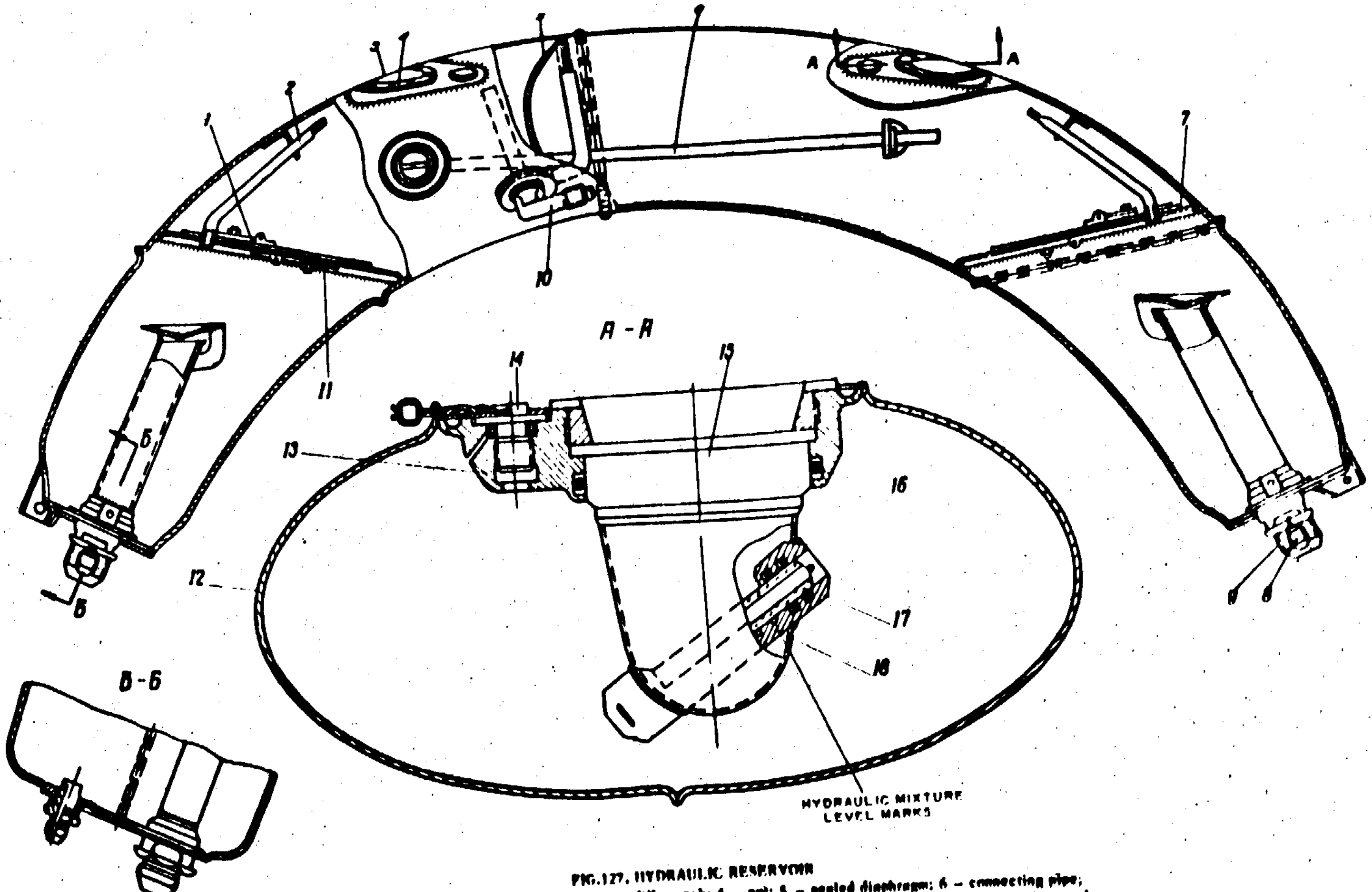


FIG.127. HYDRAULIC RESERVOIR

1 – valve with strong spring; 2 – vent pipe; 3 – filler neck; 4 – nut; 5 – sealed diaphragm; 6 – connecting pipe; 7 – separating diaphragm; 8 – drain connection; 9 – suction connection; 10 – pressurization connection; 11 – valve with weak spring; 12 – reservoir body; 13 – filler neck body; 14 – plug; 15 – sleeve; 16 – packing ring; 17 – glass tube; 18 – glass tube casing.

Specifications

1. Total capacity of main system compartment	10.5 lit.
2. Total capacity of booster system compartment	7.2 to 8 lit.
3. Volume of fluid filled in each compartment	6.5 lit.
4. Strength test pressure	5 kg/cm^2
5. Critical pressure	12 kg/cm^2

Hydraulic Pump, Type НП34-1Т (Fig.126)

The hydraulic pump is designed to built up pressure in the systems of the aircraft. The pumps are installed on the engine wheelcase with constant speed ratio and attached to the wheelcase by means of clamps fitted on the flanges of the wheelcase and of the pumps. The clamps are tightened by means of bolts. When the engine is operated, the pump experiences a considerable vibration stress. Therefore, care should be taken to prevent loosening of the bolts fixing the clamps.

The outside portion of shaft 1 is coupled to the wheelcase shaft by means of a spring clutch. The pump shaft is arranged on three bearings, two of these taking up radial loads and the third one, axial loads. The torque of the shaft is transmitted through universal joint 11 to cylinder unit 10 housed in cradle 8. There are nine holes in the cylinder unit into which nine pistons 3 are fitted. The piston rods connect the pistons to a ring which rotates together with the driving shaft. The pistons and the rods have the internal bore holes through which the lubricant is supplied to lubricate the spherical heads of the piston rods.

The cradle is fitted on trunnions 16 pivoted on ball and needle bearings 13. Thus, the cradle and the cylinder unit can be displaced by 30° relative to the shaft. When the shaft is rotating, the butt end of the cylinder unit slides over the face of slide valve 9 so that it is seated tightly upon the face due to fluid pressure and the thrust of the spring.

The piston holes are connected in alternate succession to the milled recess of the slide valve which is coupled to the suction line, and to the milled recess coupled to the pressure line. Inasmuch as the cylinder unit axis forms a certain angle with the driving shaft axis, pistons 3 reciprocate in the piston holes of the cylinder unit when the shaft and the cylinder unit connected to it are rotating. Meanwhile, the fluid is sucked from the suction line into those chambers where the pistons move from right to left from the unit, and the fluid is forced out by the thrust of pressure through the respective milled recess to the pressure line from those chambers where the pistons are moved from left to right into the unit.

Some fluid is taken from the pressure line to the pump capacity regulator which causes the angle of tilt of the cylinder unit to change depending upon the amount of pressure in the system and leads to a change in pistons travel and hence in the pump capacity.

To change the angle of tilt of the cradle and of the cylinder unit housed therein, the capacity regulator employes cylinder 4.

As the pressure rises, slide valve 5 of the capacity regulator is caused to displace at a pressure of 180 kg/cm^2 so that adjusting spring 6 of the regulator is compressed. In this case the fluid is fed to the regulator cylinder which is set in motion to reduce the tilt angle of the cradle.

At a pressure of 210^{+5}_{-25} kg/cm^2 the regulator cylinder sets the cradles into position almost coaxial to the driving shaft, the further increase in pressure being limited due to exhaust of fluid through the regulator cylinder port into circulating line 2. In this position of the cylinder unit the pump capacity is

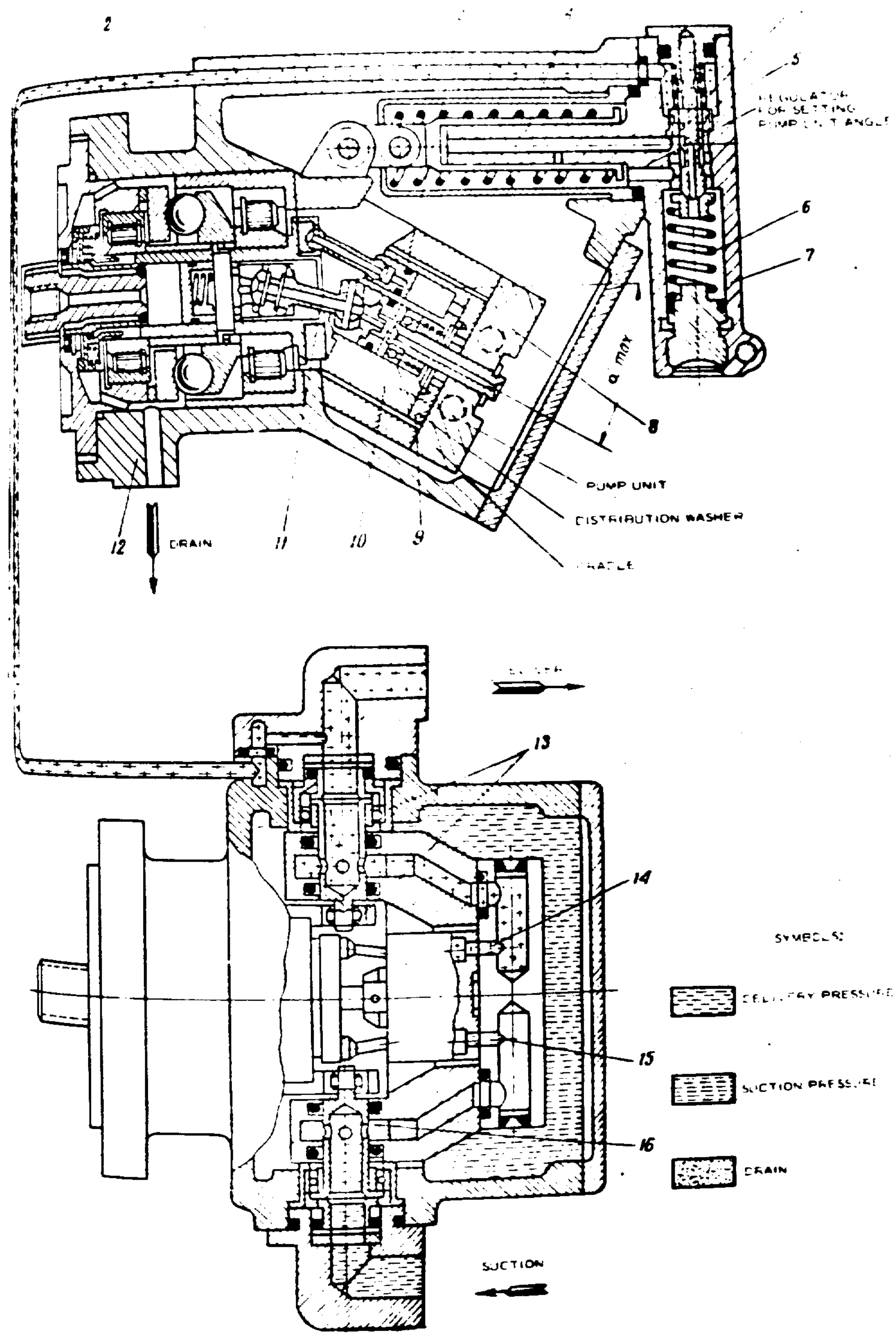


FIG.128 [illegible] PUMP

[illegible] — pump shaft; 2 — outer circulating line; 3 — piston; 4 — capacity regulator cylinder; 5 — regulator slide valve; 6 — adjusting [illegible] spring; 7 — regulator body; 8 — cradle; 9 — slide valve; 10 — cylinder unit; 11 — universal joint; 12 — body; 13 — cradle bearings; 14 — pressure line; 15 — suction line; 16 — trunnions zero. In order to cool the pump, continuous fuel return of 2 to 2.5 lit/min. is maintained in the circulating line.

If the fluid is consumed, the pressure in the system drops, and adjustment spring 6 shifts slide valve 5 of the regulator into the initial position. Due to this, the pressure in the regulator cylinder cavity is released through the slide valve, and the cradle acted upon by the retracting spring of the regulator moves into the position in which the capacity of the pump is increased.

The inner cavity of the pump communicates with the pump circulating line. The fluid leaking through the packing gland of the driving shaft passes into the drain line and is released into the atmosphere.

Pump Specifications

1. Pump speed:
   minimum .... 500 r.p.m.
   maximum .... 4000 r.p.m.
2. Direction of pump shaft rotation as specified by the State Standard ГОСТ 1630-48 .... right-hand
3. Zero displacement at which fluid supply is stopped .... 210^{+5}_{-25} kg/cm²
4. Inlet pressure .... 2.2 atm. abs.
5. Pump capacity at delivery pressure 180 kg/cm², inlet pressure 2.2 atm. abs. and temperature of fluid +20 ±5°C:
   at the initial stage of operation ..... not less than 35 lit/min.
   at the end of service life .... not less than 31 lit/min.
6. Pump capacity at speed 500 r.p.m., delivery pressure 175 kg/cm², inlet pressure 2.2 atm. abs. and temperature of fluid +75° ±5°C :
   at the initial stage of operation ...... not less than 4 lit/min.
   at the end of service life .... not less than 2.5 lit/min.
7. Maximum pressure in the system at zero capacity .... 210_{-12} kg/cm²

Check Valves (Fig.129)

The check valve is intended to ensure the delivery of fluid in one direction as indicated by an arrow engraved on the valve body. When the pressure at the inlet and outlet of the valve is balanced, piston 2 is displaced by retracting spring 1 so that it sinks with its tapered end into a seat and cuts off the line. When the pressure at the valve inlet drops, the valve maintains the pressure inside the cavity which it cuts off and prevents the flow of the fluid from the cavity. The valve body is made of duralumin, and the connection which forms the seat is made of steel.

The hydraulic system uses check valves of similar design with the exception of the passage areas listed below:

674500Б	dia. 4 mm,	connection pipe thread	12x1
674600Б	dia. 6 mm,	same	14x1
671600Б	dia. 8 mm,	same	16x1
671700Б	dia. 10 mm,	same	18x1.5
671800Б	dia. 12 mm,	same	20x1.5

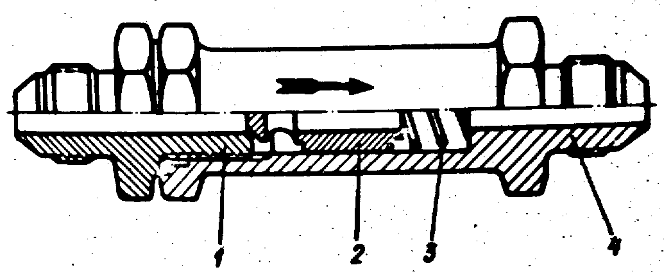


FIG.129. CHECK VALVE
1 – pipe connection; 2 – piston; 3 – spring; 4 – body.

Installed at the outputs of the pumps are the steel cast valves intended to increase the reliability of the system.

CAUTION! When the check valves are mounted, care should be taken that the arrow on the valve bodies corresponds to the direction of delivery required by the working conditions of the system.

ФГ11/1С Filter (Fig.130)

ФГ11/1С filter is intended for filtering the fluid from foreign matter. Maximum capacity of the filter is 40 lit/min.

The hydraulic resistance of the filter in case the consumption is 30 lit/min and the temperature of fluid and of the medium is +20°C lies within 2.5 kg/cm^2.

The pressure differential at which the by-pass valve operates is 9 ±1 kg/cm^2.

The filter consists of cover 1, cup 9, coarse filter 10, fine filter 7 and by-pass valve 5.

The cover is screwed over the cup so that the fine filter is seated upon the grooves of the cover and the cup and sealed in place of the filter heads. The coarse filter is mounted on the filter cover.

The filter cavity is divided so that the fluid coming into the inlet connection before reaching the outlet connection should necessarily flow first through the fine and then the coarse filters.

The fine filter is equipped with a corrugated nickel mesh filtering element to increase the filtering area. The filter butt ends are built into the metal heads, installed inside of the filter is a spring to ensure sufficient rigidity.

The coarse filter is made of fine section wire wound on a duralumin tube with slots.

If the fine filter is clogged and the pressure differential increases, the by-pass valve is caused to open and admit the fluid to the outlet, the filtering being made by the coarse filter alone.

Access to the filter is provided through the engine inspection hatches (Figs 123 and 125).

11Г64С Filter (Fig.131)

11Г64С filter is intended for fine filtering of АМГ-10 fluid from foreign matter.

Specifications

1. Maximum working pressure .... 220 kg/cm^2
2. Maximum capacity .... 10 lit/min.
3. Hydraulic resistance of clean filter .... within 16 kg/cm^2
4. Pressure differential at which by-pass valve operates .. 7 ±1 kg/cm^2

The filter consists of cover 1 and cup 7 which constitute the housing of fine filter 3, coarse filter 4 and by-pass valve 6.

Rubber rings are used for sealing the joint between the fine filtering element head, the cover and the cup. The wire coarse filter is screwed into the cover.

The fine filter consists of a corrugated nickel mesh filtering element which carries the metal heads soldered into it.

Installed inside the mesh filter is the frame.

The coarse filter is made of an aluminium tube with longitudinal corrugations and holes of shaped wire which forms filtering slots when wound about the tube.

The working fluid is fed through the inlet port into the interior cavity of the filter. After passing through the filtering partition of the fine filter,

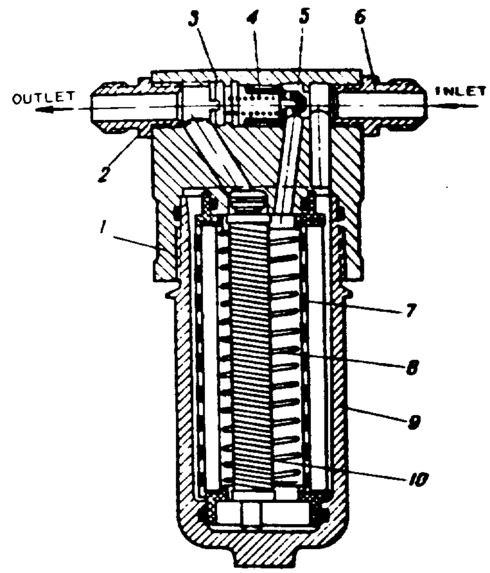


FIG.130. ΦГ-11 ʼIC FILTER

1 – cover; 2 – outlet pipe connection; 3 – nut. 4 – spring; 5 – by-pass valve; 6 – inlet pipe connection; 7 – fine filter; 8 – spring; 9 – cup; 10 – coarse filter.

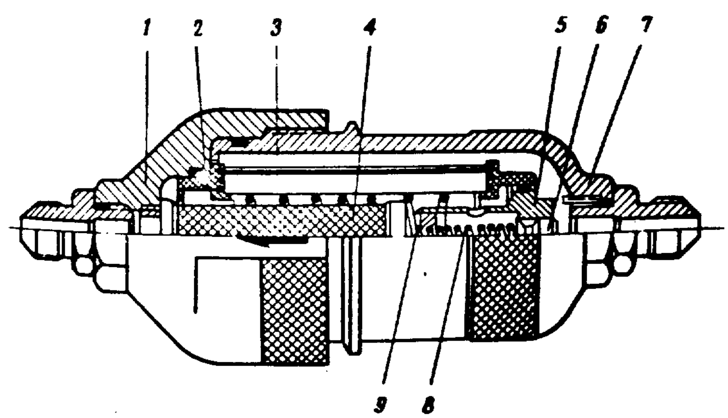


FIG.131. ПГФ-4С FILTER

1 – cover, 2 – filtering element head; 3 – fine filtering element; 4 – coarse filter. 5 – by-pass valve body; 6 – by-pass valve; 7 – cup; 8 – spring; 9 – nut.

fluid comes to the course filter and is routed through it to the outlet connection. In case the mesh filter is clogged and the pressure differential reaches 7 ± 1 kg/cm^2, the fluid passes through the by-pass valve and the coarse filter by-passing fine filter.

ГА-186М Safety Valve (Fig.132)

The safety valve serves to by-pass the working fluid from the pressure line to the return line when the pressure in the hydraulic system rises above 240^{+5} kg/cm^2.

ГА-186М safety valve consists of body 1, ball valve 3, retracting spring 2, adjustment spring 4, filter 5.

Apart from these, there are main valve 6, adjustment screw 8 and ball 7. When the pressure in the pressure line exceeds the maximum pressure at which the thrust exerted by spring 4 is overcome, the ball valve is displaced to the right.

With further minor increases in pressure, the supply of fluid through the ball valve increases accordingly. But inasmuch as cavities A and Б are interconnected by means of an orifice plate, a differential of pressures in the two cavities is caused. When the force produced due to the above difference exceeds the thrust of retracting spring 2, valve 6 moves away from the seat and allows the fluid to pass to the return line so that the required pressure is maintained constant. When the pressure in the system drops to 220 kg/cm^2, ball 7 is forced by the spring to displace in the opposite direction and to close the seat. Simultaneously, the supply of fluid through orifice М as well as the difference in pressures inside cavities A and Б diminish and spring 2 smoothly returns valve 6 into its initial position due to which the return of fluid is cut off. As soon as the ball is forced into the seat and the fluid is cut off, the pressures in cavities A and Б become equilibrated.

When the pressure is within 240^{+5} kg/cm^2, the fluid is steadily leaking through the valve.

The valve is said to be cut off in case the leakage of fluid through it does not exceed 100 cu.cm. per min.

The pressure in the unit is adjusted by means of adjustment screw 8.

In case the entire fluid output of the pump is exhausted through the valve, the pressure may rise to 262 kg/cm^2.

Spherical Hydraulic Accumulator (Fig.133)

The aircraft is provided with two hydraulic accumulators, one per each hydraulic system.

They serve to accumulate the fluid when the system is in operation and to give the stored fluid back into the system if the quantity of consumed fluid is excessive. Besides, the accumulators provide suppression of pressure fluctuation and to absorb the hydraulic shocks.

The spherical accumulator serves also to reduce the pulsations in pressure caused by the pump.

The accumulator consists of body 4 and cover 3 which carries charging valve 1 mounted upon it. To separate the gas and hydraulic cavities, elastic spherical rubber diaphragm 5 is used. It rests by its lower portion against head 6 provided with a number of holes of small diameter.

The body is made of sheet steel, grade 30ХГСА, and the diaphragm is produced of rubber, type В-14. The fluid is supplied at pressure to the hydraulic cavity

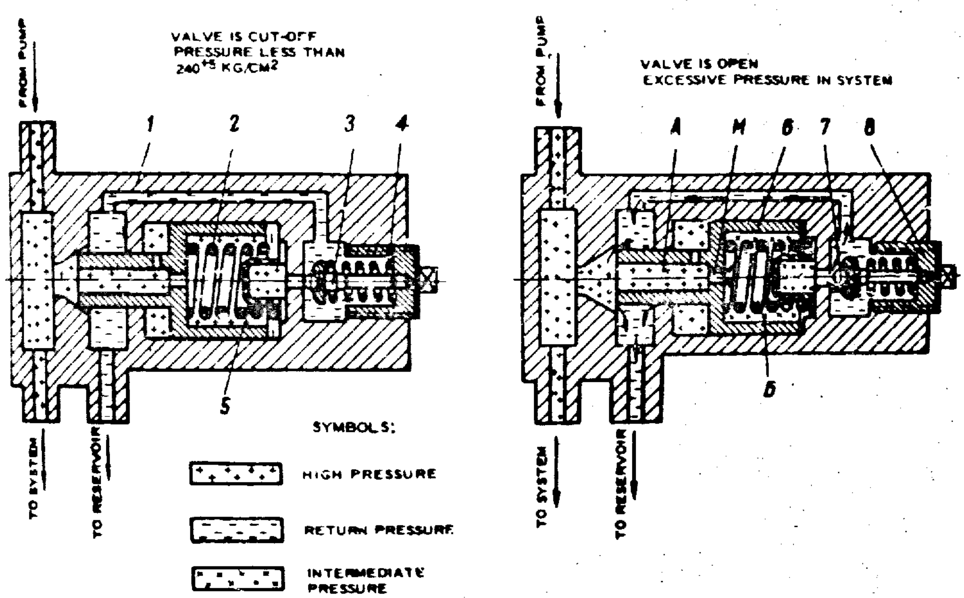


FIG. 132. ГА-186М SAFETY VALVE

1 – body; 2 – retracting spring; 3 – ball valve; 4 – adjusting spring; 5 – filter; 6 – main valve; 7 – ball; 8 – adjusting screw.

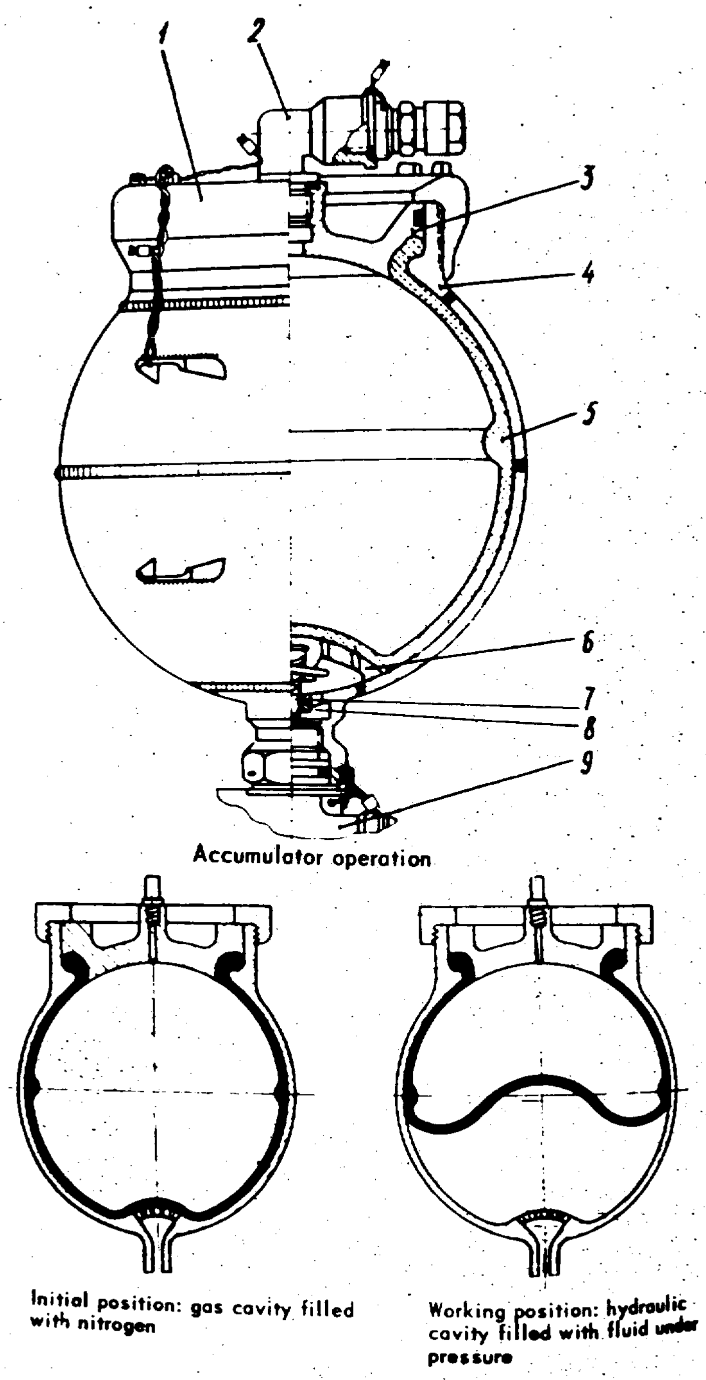


FIG.133. SPHERICAL HYDRAULIC ACCUMULATOR
1 – nut; 2 – charging valve with elbow; 3 – cover; 4 – body; 5 – diaphragm; 6 – head; 7 – screw; 8 – nut; 9 – collector.

through the collector, compresses nitrogen and deflects the diaphragm towards the cover so that a reserve of hydraulic energy is provided.

If the fluid inside the system is consumed, the compressed nitrogen forces the fluid stored inside the accumulator into the system. The charging pressure is 50^{+5} kg/cm^2. The accumulator is filled with nitrogen of the first or second grade with the dew point not above -35°C as specified by ТУМХП-4280-54.

The quantity of fluid filled into the hydraulic cavity of the accumulator at 210 kg/cm^2 is 1.15 lit.

Remote-Reading Electrical Pressure Gauge 23ДММ-250А

The remote-reading electric twin pressure gauge 23ДММ-250А serves to measure the pressure in the system. The pressure gauge consists of two pressure pick-ups, type 3Д-50/250 and one two-pointer indicator У2-250А. The pick-ups are installed in the booster and main systems. They are provided with dampers which prevent the effects of pressure pulsation on the gauge indications.

The pick-ups convert the fluid pressure into proportional displacements of the end of the tubular spring.

By means of a potentiometer the travel of the tubular spring disturbs the balanced electrical bridge; as a result, an electrical signal is sent to У2-250А indicator where it is converted into proportional movements of the pressure gauge pointers.

Specifications:

1. Model of pressure gauge 23ДММ-250А
2. Range of pressure measurements .... 50 to 250 kg/cm^2
3. Working range .... 100 to 220 kg/cm^2
4. Scale reference points .... 50; 100; 150; 220; 250 kg/cm^2
5. Pressure gauge pick-ups operate within the temperature range .... from +100° to -60°C
6. Indication errors of pressure gauge at +100°C and of indicator at +50°C should lie within:
   - ±6.5 per cent of the maximum scale reading in the working range;
   - ±8.5 per cent of the maximum scale reading in the auxiliary range.

A detailed description of the pressure gauge design is given in Book IV, Chapter II of the Technical Description.

Aircraft Connections

The inboard connections are intended for coupling to the ground hydraulic units when checking the booster and main systems on the ground.

Installed near frames Nos 27 and 28, on the right side of the recess housing the inboard connections, are two connections, namely the suction connection and the pressure connection of the main system. Installed symmetrically on the left side of the recess are the booster system connections.

The design of the suction and pressure connections is analogous (Fig.134), the only difference being the passage areas.

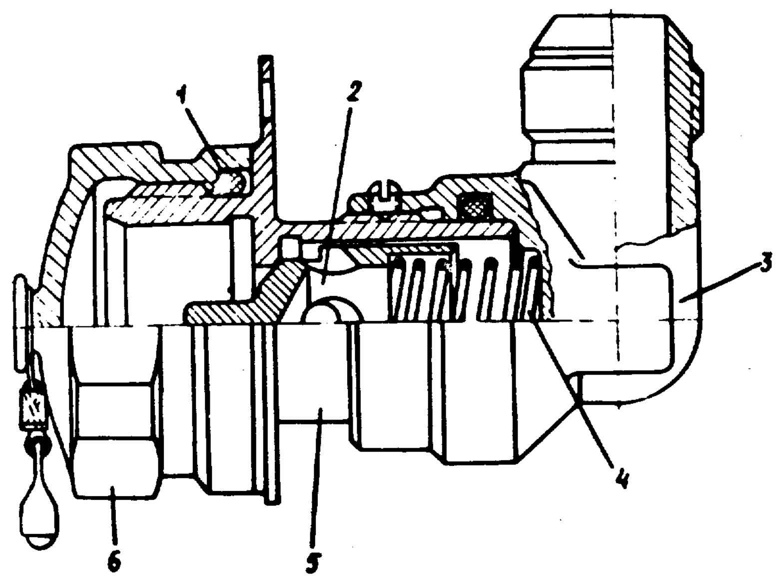


FIG.134. AIRCRAFT CONNECTION
1 – ring; 2 – valve; 3 – elbow; 4 – spring; 5 – body; 6 – plug.

The connection consists of body 5, elbow 3, valve 2, spring 4 and plug 6. When coupling the respective connections to the ground installation, the plug must be removed.

In this case valve 2 is shifted into the extreme right position by means of a lug of the ground connection acting upon the tappet of valve 2 so that the ground installation is thereby coupled to the aircraft hydraulic system.

When the ground connection pipe is removed, the retracting spring brings the valve back into the body seat due to which the line is cut-off. After this the connection is plugged, rubber ring 1 adding to the airtightness of the valve.

Charging Valve

The charging valve is intended to couple to the ground charging installation when the closed filling of the hydraulic system is employed.

The design of the charging valve is similar to that of the inboard connection (See Fig.134). It consists of the body which houses the valve head and the spring. The plug of the valve should be removed before filling.

The charging valves are installed on the right and left sides near frames Nos 27 and 28 in the recess housing the charging connections.

Line Disconnect Valves (Fig.135)

The line disconnect valves are employed to disconnect and close the pipelines which prevents leakage of fluid from the hydraulic system.

There are four disconnect valves in the hydraulic system, two of them are located in the main system and the other two are mounted in the booster system.

The valves are installed near frame No.28 (two on the right side and two on the left). They are used during disjoining of the aircraft. Each valve consists of two halves screwed together by means of a union nut.

Each half is called "locking valve" (I and III) and in its turn consists of body 1, springs 2 and 6 and heads 4 and 5. Incorporated in the left-hand half is sleeve 6 whereas the right-hand half mounts pipe connection 7.

When the halves are screwed together and the union nut is driven home, the body of the right-hand half displaces the sleeve to the extreme left-hand position, the tightness of the valve being provided by the rubber packing ring housed in the groove of body 1.

When the sleeve is pressed off (head 4 simultaneously displaces head 5 to the extreme right position), the ducts for fluid supply are opened, and the pipes get coupled to the pipe connection of body 1 on the right side and to screwed-in pipe connection 10 on the left side.

When nut II is unscrewed and the valve halves are disconnected, sleeve 3 is returned to the seat of head 4 by means of the spring, and head 5 is displaced to seat 1 by spring 6. Thus, the by-pass ducts are shut off and the lines are disconnected.

The disconnect valves installed in the L.G. and booster systems have the same design, the only difference being the passage areas of the pipelines.

Pipelines

Connection of the units of the hydraulic system is provided by means of pipelines. The pipelines of the pressure section and the working lines after the valves

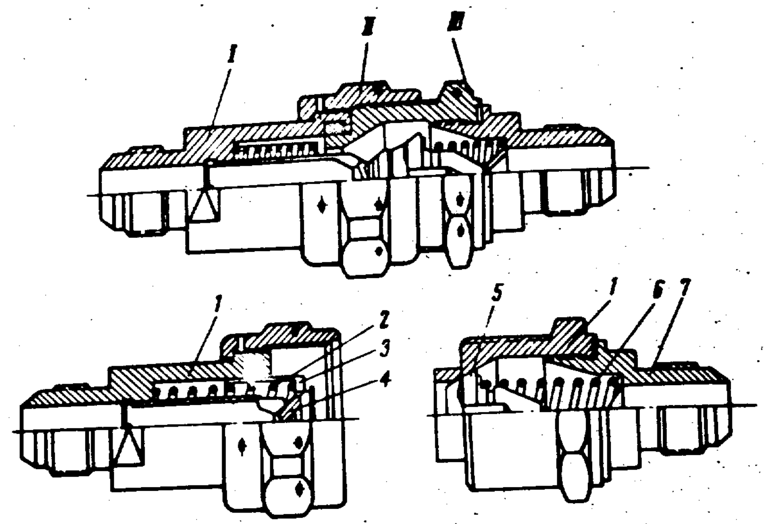


FIG.135. LINE DISCONNECT VALVE

I – locking valve; II – union nut; III – locking valve; 1 – body; 2 – spring; 3 – sleeve; 4 – head; 5 – head; 6 – spring; 7 – pipe connection.

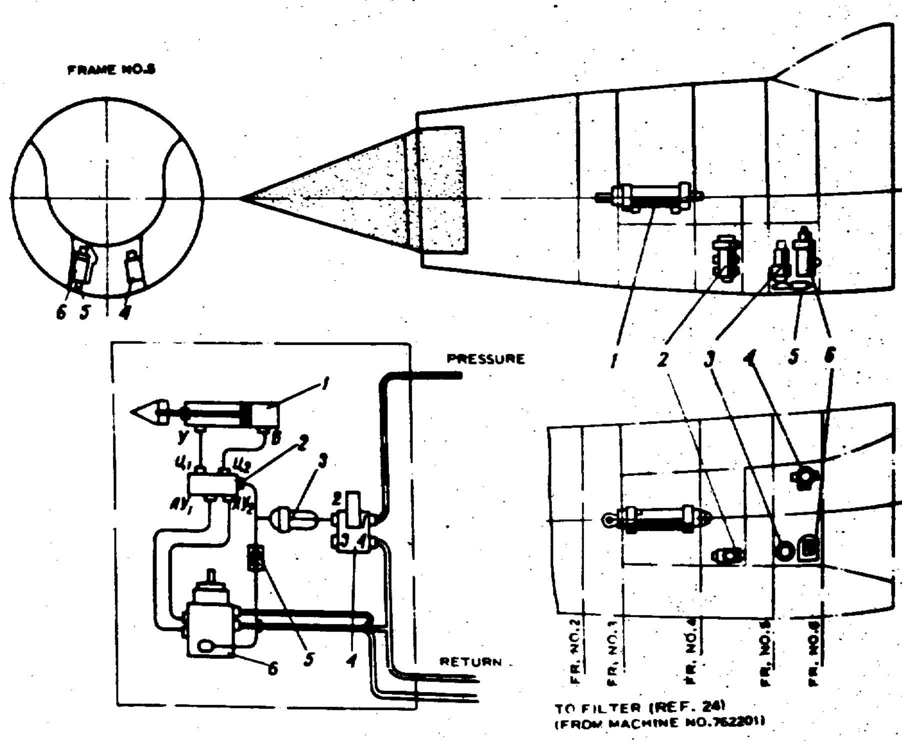


FIG.136. CONE CONTROL SYSTEM (Reference numbers are as in Fig.122)

1 – cone cylinder; 2 – cone cylinder hydrolock; 3 – cone filter 11Ф-4Б-1; 4 – cone valve ГА-184У; 5 – check valve; 6 – cone control unit АЗ-7У-1.

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of the hydraulic system are made of stainless steel pipes X18H10T, while the return lines are manufactured of duralumin pipes AMГM.

Expansion of duralumin and steel pipes is performed according to Standard 103AT55 and the pipes of stainless steel are expanded according to Standard 104AT55.

Coupling of the pipes to the pipe connections of the units and fittings is performed according to Standard 1000A55.

Prior to mounting, the strength of the steel pipelines is tested at a hydraulic pressure of 315 kg/cm^2 and the strength of pipelines made of AMГM duralumin is tested at a pressure at 75 kg/cm^2.

To attach the pipelines, the multi-seat mounting blocks are used to fix bunched pipes by means of tie bolts. Some blocks are attached rigidly, while the others are suspended from the pipes to provide rigidity of the bunched pipes and prevent contact between them.

The single pipes are attached to the airframe by means of clips.

The attached blocks are secured directly to the airframe or fixed thereat by means of attachment unit such as shapes, angles, etc.

The block seats carrying the pipes are covered with rubberized gaskets.

Flexible rubber hoses are not used in the hydraulic system. There are however two suction hoses to couple the reservoir branch pipelines to the pumps.

Pipeline Marking

Steel pipelines of the hydraulic system are not painted, while the return lines are painted grey.

In order to simplify maintenance of the system as well as to facilitate identification of the pipes of any system required, the pipes are marked-out according to the respective systems.

Therefore, any given line carries the marking of the system to which it belongs.

The marks are made at the ends of the pipes and distributed along the whole pipe length at definite spacing.

Some of the marks are written in full words, e.g. "HIGH PRESSURE" or "SUCTION", whereas the other marks are abbreviated, e.g. "CONE EXT." which implies that the given pipes belong to the cone extension pipeline system.

3. Cone Control System (Fig.136)

Automatic follow-up cone control system УВД-2M is intended to provide reliable operation of the air intake and the engine whatever may be the conditions of flight.

The automatic cone control system is switched on by means of the switch CONE CONTROL.

In case the automatic cone control fails, the cone can be operated manually by changing the selector switch AUTOMATIC – MANUAL.

When the switch is set into position AUTOMATIC , the system is operated automatically (principal mode) and if the switch is turned into position MANUAL, the cone is extended or retracted by hand.

The cone control system consists of ГА-184У electromagnetic valve 4, cone cylinder 1, hydrolock 2, filter 3, АУ-35-1 control unit 6, and check valve 5.

When the pressure in the system drops to 35 kg/cm^2, the hydrolock closes and fixes the cone in the position at which the cone has been at the instant of pressure drop.

The check valve installed in the pressure line connected to the control unit serves to prevent cylinder displacement from its true position caused by excess thrust of the air upon the cone.

Cone Automatic Control

(The selector switch is in position AUTOMATIC)

The automatic cone control depends on the mode of operation of the engine. The principle utilized in the cone control system consists in the relation between the extension of the cone and the degree of thrust on the compressor, which is actually the ratio between the absolute static pressure at the compressor output and the absolute static pressure at the compressor input.

The cone control unit is fed with an electric pulse which varies in proportion the degree of thrust on the compressor controlling the supply of fluid into the cone actuating hydraulic cylinder cavities.

The cone control system is interlocked by the L.G. limit switch. When the landing gear is extended, the cone system is switched off while in case the landing gear is retracted, the circuit of the system is closed and the cone control is effected either automatically or manually.

Besides, the cone system ensures additional extension of the cone depending on the angle of stabilizer deflection during a straight flight.

Switch CONE CONTROL engages simultaneously the whole system and the cone electric valve ГА-184У. The switch is mounted on the left-hand console installed in the cockpit.

To determine the position of the cone, a cone position indicator is employed whose scale graduated in per cent. It is mounted on the left-hand electric board of the instrument panel.

Besides, there is signal lamp CONE EXTENDED which lights up when the cone is extended to 3-6 mm.

Cone Manual Control

(Selector switch is in position MANUAL)

The manual control of the cone extension is employed in case the automatic control fails and, hence, is used as the emergency system when the automatic system is out of operation. In order to change over to the manual control, the selector switch should be set into position MANUAL. To extend or retract the cone, the setting knob mounted on the cone position indicator must be turned depending upon M-number achieved.

4. Cone Control Units

ГА-184У Valve (Fig.137)

ГА-184У valve is a two-position electromagnetic servovalve. It consists of ball valve 4 and slide valve 3 controlled by the ball valve and two pistons.

The parts of the valve are assembled inside body 1 made of aluminium alloy.

When the electromagnet is cut off, the valve ball is acted upon by the pressure of fluid fed from the pump through a hole in the body and is set in the right-hand position due to which the passage of fluid to the inner cavity of first piston 9 is open.

Since the area of the given piston acted by the fluid exceeds the area of the piston of slide valve 2, the slide valve is displaced into extreme left-hand position under the pressure of fluid applied to the first piston.

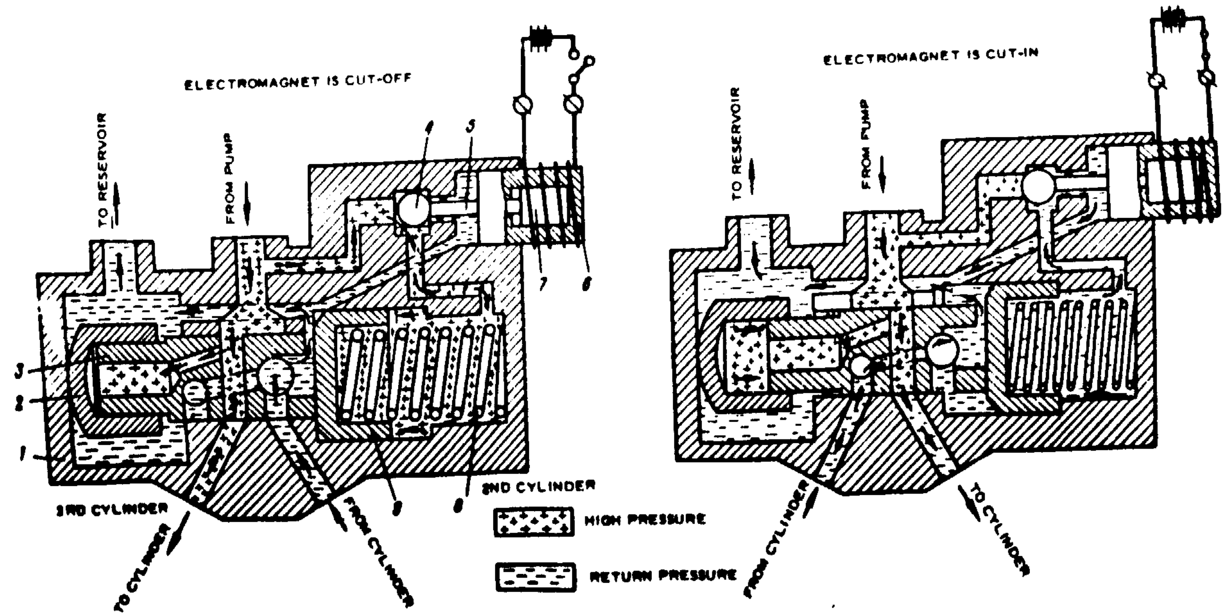

FIG.137. ГА-184У VALVE

1 – body; 2 – piston; 3 – slide valve; 4 – valve ball; 5 – tappet; 6 – coil housing; 7 – core; 8 – spring; 9 – piston.

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The slide valve is set into the position where the cavity 1st PUMP is coupled to the cavity 3rd CYLINDER while the cavity 2nd CYLINDER is coupled to the cavity RESERVOIR.

When the electromagnet is energized, core 7 is caused to travel and forces the valve ball into the seat so that the passage of fluid from connection 1st PUMP to the inner cavity of the piston is shut off and the piston cavity is coupled to the return line connected to the reservoir.

As the fluid pressure is exerted upon the left-hand butt end of the slide valve, the slide valve is displaced into the extreme right-hand position due to which spring 8 is compressed and the piston is moved as far as it goes.

The slide valve moves into the position where the cavity 1st PUMP is coupled to the cavity 2nd CYLINDER and the cavity 3rd CYLINDER is connected to the cavity RESERVOIR.

If the electromagnet is de-energized, the pressure returns the valve into the initial position.

Cone Cylinder (Fig.138)

The cone cylinder is intended to extend and retract the cone. It consists of housing 4, rod 5, cover 7, eyebolt 3, bush 6, bracket 2 and bush 1. The design of the cone cylinder is analogous to a common cylinder divided by the piston into two cavities.

Each cavity is connected by the pipelines to the cone hydrolock. Bush 6 is designed to adjust the motion of the piston whose stroke is 200 ±1 mm, and to limit the rod motion when the rod is extended.

Attached to the cylinder rod is bracket 2 of special design which is supplied with a bush to attach the cable of the УПОС-3 feedback pick-up mechanical drive.

The bracket is mounted on eyebolt 3 screwed into the piston rod and is secured by means of the eyebolt lock nut.

АУ-35-1 Cone Control Unit (Fig.139)

The cone control unit is employed to control the supply of fluid from the main hydraulic system into the cone cylinder cavities which provides extension or retraction of the cone.

The unit consists of:

(a) apparatus 7 of nozzle-throttle type controlled by polarized relay 6;

(b) reducing valve 3;

(c) distributing slide valve 1;

(d) plate orifices 5;

(e) filter 4.

The fluid supplied from the main hydraulic system is fed through connection 4 to reducing valve 3 and slide valve 1. From the reducing valve the fluid is delivered at a pressure of 75 kg/cm^2 through two parallel routes. Each route contains two series resistors of which one is a plate orifice used as a fixed resistor and the other is a variable resistor of the nozzle-throttle type.

When no signal is fed to the relay windings, the throttle is in neutral position and equal quantities of fluid are supplied through the two valves so that there is no difference in pressures at the butt ends of the slide valve and, hence, the slide valve is set into the neutral position.

As an electric pulse is applied to one of the relay windings, the throttle is displaced through an angle whose magnitude depends on the value of the pulse applied

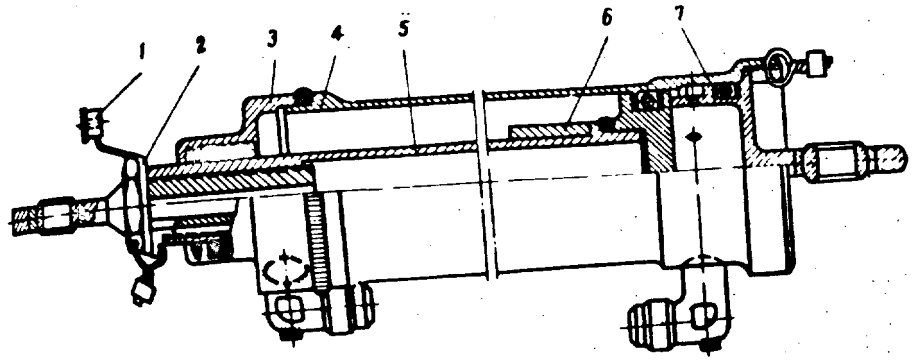

FIG.138. CONE CYLINDER
1 – bush; 2 – bracket; 3 – eyebolt; 4 – housing; 5 – rod; 6 – bush; 7 – cover.

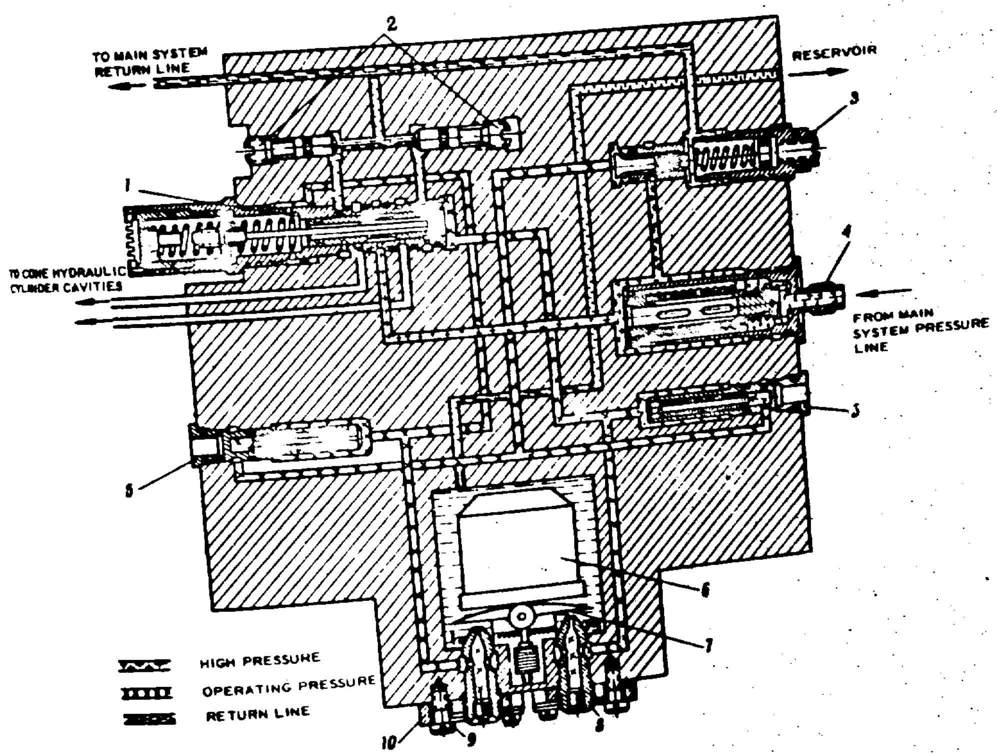

FIG.139. AY-15-1 UNIT SCHEMATIC DIAGRAM
1 – distributing slide valve; 2 – adjusting screw; 3 – reducing valve; 4 – filter; 5 – plate orifice; 6 – ГМ1-12 relay; 7 – throttle; 8 – nozzle; 9 – bolt; 10 – locking plate.

Due to displacement of the throttle the gap between the throttle and the nozzle varies. Thus the gap in one nozzle increases while the gap in the other diminishes. Variation of the gaps leads to changes in the quantity of fluid delivered through the nozzle which in turn causes a pressure differential to appear at the butt ends of the slide valve. The pressure differential causes the slide valve to displace to open the passage to one cylinder cavity and connect the other cavity to the return line. The pressure differential at the distributing slide valve butt ends and fluid consumption in the hydraulic cylinder cavities depend upon the value of the electric pulse fed to the relay windings.

To limit the speed of displacement the cone hydraulic cylinder rod, the return lines from the cylinder are provided with adjustable flow restrictors installed in the distributing valve.

Cone Cylinder Hydrolock (Fig.140)

The cone cylinder hydrolock serves to fix the cone cylinder rod in the position where the piston occurs to be at the instant of pressure drop.

The hydrolock consists of body 3, bush 5, slide valve 4 with thermovalve 12, adjusting springs 10, piston 7, support 6, cover 11 and control pressure connection 1 with throttle assembly 13.

The body of the hydrolock is provided with four connections to couple the hydrolock into the line RETRACTION-EXTENTION.

The control pressure is supplied through a separate connection.

The fluid passes through the throttle assembly which prevents undue operation of the slide valve caused by pressure pulsations, shifts the slide valve and contacts adjusting springs. At a pressure below 70 kg/cm^2 the hydrolock is open. As the slide valve reaches the support, it interconnects the body connections in couples. In this case the fluid circulates freely in the lines RETRACTION-EXTENSION while the cone is in operation. But as the pressure in the main system drops to 35 kg/cm^2, the adjusting springs return the slide valve into the initial position and the latter traps the control lines between its shoulders so as to fix the rod in place, irrespective of the sense of the load applied to the cylinder rod, since the fluid cannot be forced into the system.

The slide valve is mounted in the bush so that there is a clearance of 4 to 8 microns which ensures the desired sealing of the cylinder cavities.

The thermal expansion of the trapped fluid does not cause a pressure rise since thermovalve 12 is built into the slide valve; when the pressure is at 240 +10 kg/cm^2, the thermovalve opens and releases the pressure into the return line.

The motion of the slide valve is limited by support 8 which accommodates the piston. The piston prevents further compression of the adjusting springs. The hydrolock is adjusted by means of the cover.

11Г Ф-4Б-1 Filter

The design of 11ГФ-4Б-1 filter differs from that of 11ГФ-4С because it is not equipped with a safety valve so that the line of direct supply of fluid is cut-off when the gauze is clogged. The other things pertaining to the design of the 11ГФ-4Б-1 and 11ГФ-4С filters are analogous.

The description of the design of the 11ГФ-4С filter is given in this Chapter under Main System Pressure Section.

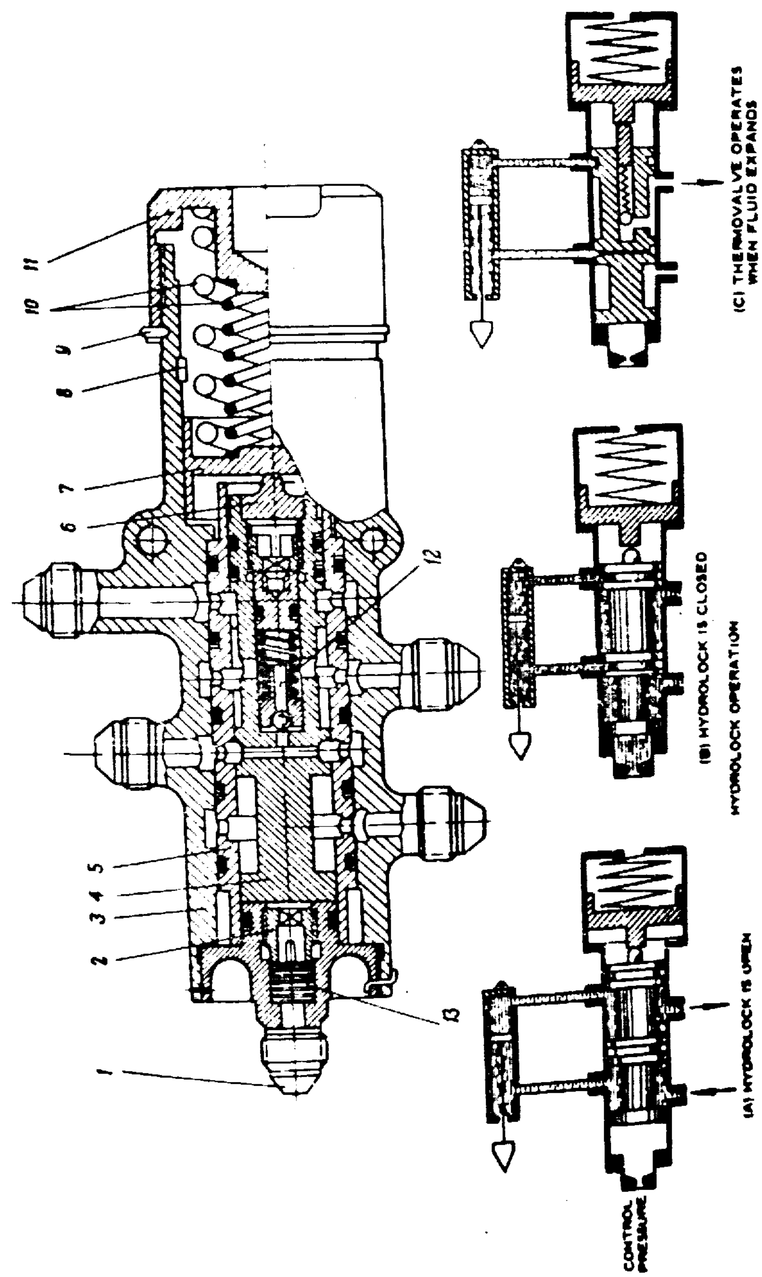

FIG.140. CONE CYLINDER HYDROLOCK

1 – control pressure connection; 2 – nut; 3 – body; 4 – slide valve; 5 – bush; 6 – support; 7 – piston; 8 – locking pin; 9 – locking ring; 10 – adjusting springs; 11 – cover; 12 – thermovalve; 13 – throttle assembly.

5. Anti-Surge Shutters Control System (Fig.141)

The anti-surge shutters control system comprises two cylinders 7 actuating the shutters, ГА-184У hydraulic electromagnetic valve 9 and two throttles 8 and 10.

Throttle 10 mounted in the shutters retraction line is intended to provide smooth opening of the shutters and to prevent abrupt opening of the shutters acted by external forces when the retraction line is coupled to the return line.

Installed in the extention line is differential throttle 8 which serves to provide a variable delay of extension and retraction of the anti-surge shutters. (The extension takes 1 to 2 sec. and retraction takes 3 to 4 sec.). The shutters are automatically extended or retracted in flight depending upon the flight speed, throttle control lever position and stabilizer deflection angle.

If the sutters are controlled automatically the system starts to operate when the flight speed amounts to $M \geq 1.35$. Simultaneously the ГА-184У electrovalve is cut in. The circuit of the ГА-184У valve includes the surge interlocking relay and the stabiliser deflection angle shutter opening interlocking microswitch.

If necessary, the shutters can be controlled manually by means of the ППН-45 change-over switch which can be turned in one of the three positions: AUTOMATIC, OPEN and CLOSED.

The anti-surge shutters are opened under the following flight conditions:

1. $M > 1.35$, the engine control lever is set within the range from the rest CUT-OFF to MAXIMUM.

2. $M > 1.35$, the stabiliser nose deflects downward by over minus 20° or upwards by over plus 2°.

Thus, the shutters open in case the two conditions mentioned above are satisfied. The shutters are held in the open and closed positions by the fluid pressure.

6. Anti-Surge Shutters Control Units

Shutters Cylinder (Fig. 142)

The shutters cylinder consists of body 3, rod 2, cover 1 and limiting bush 4.

The cylinder is arranged in the kinematic line so as to cause the shutters and the cylinder rod to extend simultaneously.

Each shutter is driven by a shaped rod which is attached to the shutter with one end and screwed directly into the cylinder rod with the other end. The limiting bush is used to obtain a definite travel of the piston and, hence, a definite angle of opening the shutters.

Shutters Throttle (Fig.143)

The shutters throttle installed in the retraction line consists of body 1, cover 6, set of throttle washers 2 and rings 3 fixed together by nut 5.

The fluid delivered through the holes in the throttle washers is delayed due to which the extension of the shutters is made more smooth.

Differential Throttle (Fig.144)

The differential throttle is designed of connection 1 with the throttle, and valve with the throttle which are housed in common body 2.

Each throttle consists of a set of throttle washers and distance washers. The valve has a through port made in the tapered butt end intended to connect the throttle of valve 3 to the common cavity.

When the fluid pressure is applied to the differential throttle in the direc-

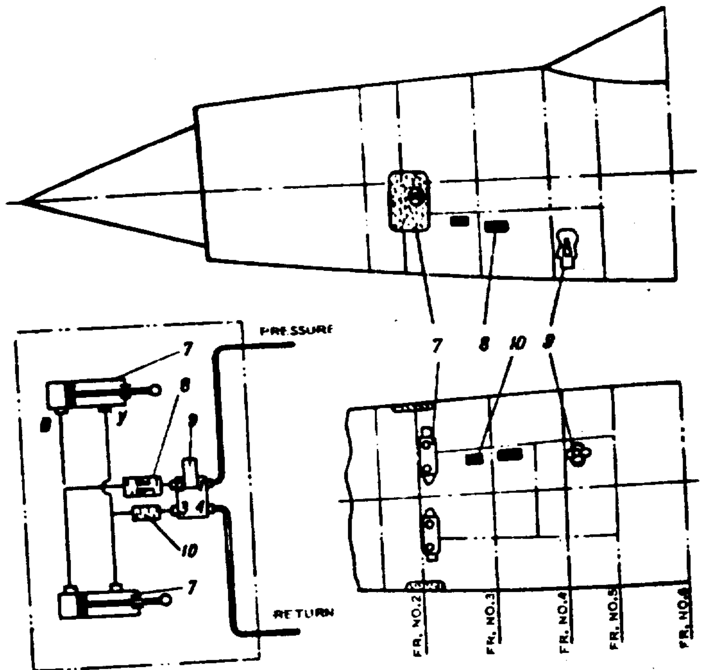

FIG.141. ANTI-SURGE SHUTTERS CONTROL SYSTEM (Reference numbers are as in Fig.122)

7 – anti-surge shutters cylinder; 8 – differential throttle, 9 – CA-184Y valve; 10 – throttle.

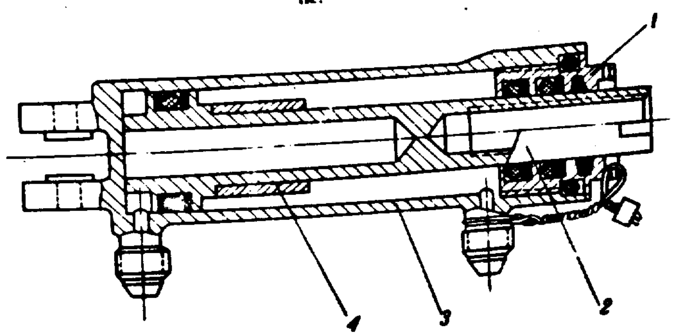

FIG.142. SHUTTERS CYLINDER

1 – cover; 2 – rod; 3 – body; 4 – limiting bush.

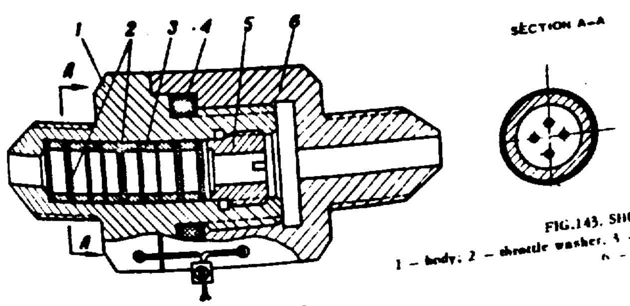

FIG.143. SHUTTERS THROTTLE

1 – body; 2 – throttle washer, 3 – distance ring; 4 – packing ring; 5 – nut; 6 – cover.

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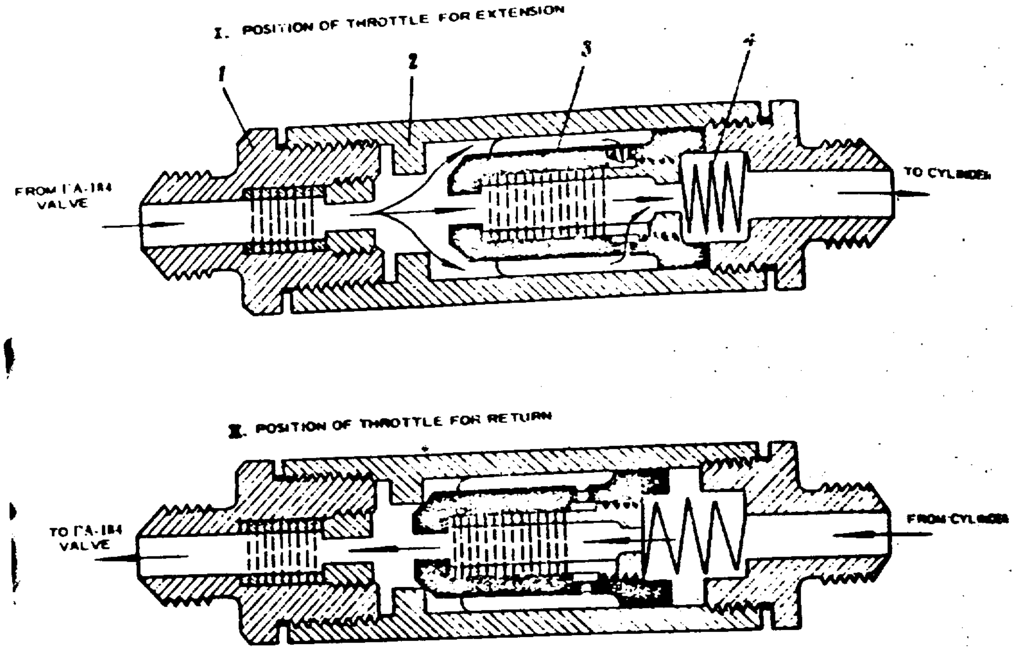

FIG.144. DIFFERENTIAL THROTTLE
1 – connection with throttle; 2 – body; 3 – valve with throttle; 4 – spring.

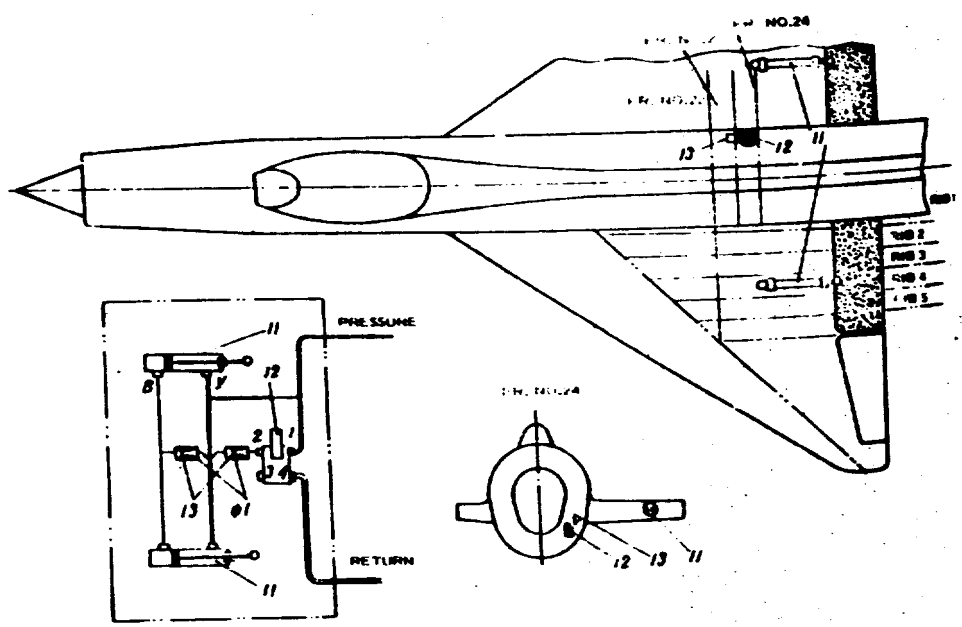

FIG.145. WING FLAPS CONTROL SYSTEM (Reference numbers are as in Fig.122)
11 – wing flaps cylinder; 12 – wing flaps valve ГА-184У; 13 – throttle.

as indicated by an arrow on the body (extension of shutters), the fluid passes through the throttle in the connection, causes the valve to displace aside and flows through the grooves and radial drillings in the valve so that it enters the inlet connection by-passing the throttles inside the valve. Thus, only one valve is engaged, to cause a delay in extension of the shutters by 1 to 2 sec.

In case the fluid pressure is applied in the direction opposite to the arrow on the body (retraction of shutters), the fluid first passes through the valve throttle washers set since the valve is now forced into the seat of the body by the spring and by the fluid pressure; then the fluid passes through the port made in the valve and through the throttle inside the valve and finally enters the system. Inasmuch as the fluid is delivered through two throttles, the time of retraction of the shutters is 3 to 4 sec.

ΓA-184Y Shutters Valve

Installed in the anti-surge shutters control system is a valve, type ΓA-184Y. The description of the valve is given in the Section Cone Control Units.

7. Wing Flaps Control System (Fig.145)

The wing flaps control system comprises the following units:

(a) ΓA-184Y electromagnetic valve 12;

(b) two actuating cylinders 11.

In order to obtain the required speed of flap extension (2 to 3 sec.), the extension line is provided with two throttles, 1 mm dia., installed in series. In the case of checking the system on the ground, asynchronous extension of the flaps is permissible, the lag being equal to one complete travel of the flap (so that after a complete extension of one flap, the other only starts extending).

In the UP position the wing flaps are kept in place by the mechanical locks of the hydraulic cylinders and in the DOWN position they are retained by the fluid pressure.

The wing flaps cylinders are so connected into the hydraulic system that the pressure for RETRACTION is delivered steadily from the system, while the pressure for EXTENSION is delivered from the ΓA-184Y valve. When the valve is cut in for EXTENSION, the cylinder rods are extended by virtue of difference in the areas of the cylinder pistons (the area of the piston for RETRACTION is smaller than the area of the piston for EXTENSION).

With the valve set in position RETRACTION, the extension line communicates with the return line, hence the cylinder rods are caused to retract due to the pressure of fluid constantly delivered to the system. Since the flaps are not fixed in the extended position, they are retracted due to the action of the aerodynamic load produced when a certain speed is achieved.

Therefore, the aircraft wing flaps can adequately be referred to as the flaps of floating type. With the wing flaps such as these, the higher the speed the less is the extension angle. The fluid is forced through the extension line to the system to recharge the accumulators or is released through the safety valve into the return line when the pressure exceeds 240^{+5} kg/cm^2.

The ΓA-184Y valve is controlled from board M3-1 located in front of the engine control lever on the horizontal section of the left-hand console. There are two buttons on the console: EXTENSION and RETRACTION.

The lights of the warning lamps illuminating the pointers are directed to the respective buttons.

When the button EXTENSION is depressed, the ГА-184У valve delivers the fluid for the flap extension and the wing flaps are set into a position depending on the flight speed.

When wing flaps are set into the extended position, the inscription WING FLAPS EXTENDED appears on the instrument panel. In case the landing gear is still retracted while the wing flaps are set in the extended position, the inscription LANDING GEAR EXTENSION appears on the warning light panel ЩС-2.

8. Wing Flaps Control Units

Wing Flap Cylinder (Fig.146)

The wing flap cylinder is intended for extension and retraction of the wing flaps. In the extended position the cylinder is retained by the fluid pressure and in the retracted position they are retained by the fluid pressure and the mechanical ball lock.

The wing flap cylinder consists of sleeve shaped body 1, extending rod with ball lock 2 and adjusting bolt 4, stationary rod 6 and bush 5 which is used as the locking mechanism.

At the end of the cycle RETRACTION the balls of the lock built into the rod piston press locking mechanism bush 5, compress the springs and displace the bush to the left unless the balls get into the recess made on a separate bush fixed in the body.

At this instant the locking mechanism bush acted on by the springs is caused to displace to the right, forces the balls into the recess, passes above them, fixes them so that they cannot fall out.

In this position the cylinder rod is locked.

When the wing flaps are extended, the locking mechanism bush acted upon by the fluid pressure is caused to travel to the extreme left position and release the balls. Since the balls are no longer retained due to extens... of the rod, they fall back from the recess, and the lock is opened thereby.

Stationary rod 6 with the piston is designed to reduce the area of the extending rod during extension.

The permissible axial play in the ball lock in the fixed position is 0.2 to 0.7 mm.

ГА-184У Wing Flap Valve

The wing flaps control system is fitted with ГА-184У valve.

The description of the valve is given in the Section "Cone Control System."

9. Air Brakes Control System (Fig.147)

The air brakes control system consists of a check valve with thermovalve 16, ГА-184У valves of which valves 17 are the side air brakes valves and valve 18 is the ventral air brake valve. Besides, there are cross-feed valve 15 and three cylinders for extension and retraction of air brakes 14 and 19.

The air brakes are controlled by button КВ-6 mounted on the throttle control lever (Fig.124).

The air brakes control system begins at the composite valve which is installed in the pressure line and composed of a check valve and a thermovalve.

The pressure line at the outlet of the check valve is branched to the side air brake valve ГА-184У and to the ventral air brake valve ГА-184У. The outlet com-

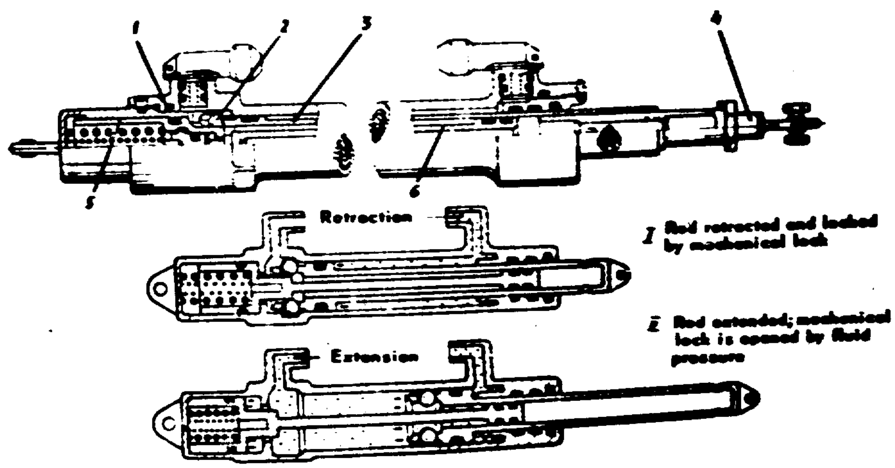

FIG.146. WING FLAPS CYLINDER
1 – body; 2 – ball lock; 3 – rod; 4 – adjusting bolt; 5 – bush;
6 – stationary rod.

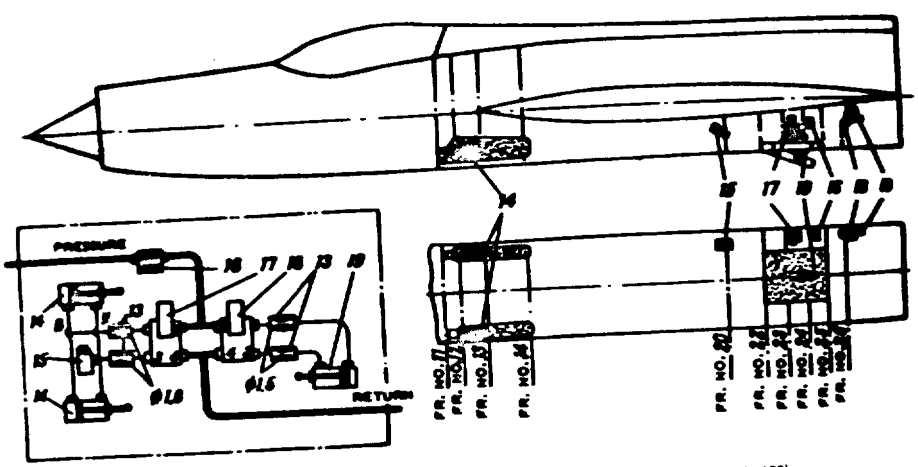

FIG.147. AIR BRAKES CONTROL SYSTEM (Reference numbers are as in Fig.122):
13 – throttle; 14 – side air brake cylinder; 15 – cross-feed valve; 16 – check valve with; 17 – side air brake valve ГА-184У; 18 – ventral air brake valve ГА-184У; 19 – ventral air brake cylinder.

sections of the valves are coupled with the air brake cylinders, respectively. The extension and retraction lines of the side air brakes can communicate through the cross-feed valve.

The cross-feed valve is intended for connection (cross-feeding) of the side air brake control system so as to prevent occasional closing of the side air brakes in case the system is pressurized when the maintenance personnel work nearby the brakes.

The ГА-184У valve of the third air brake is installed in the system to ensure the interlocking of the system when the drop fuel tank is attached. When the tank is attached, the ventral air brake does not operate since the limit switch installed at the drop tank attachment fitting is depressed and ГА-184У valve is set for constant retraction.

In this case only side air brakes can be used.

The air brakes are controlled as follows:

When the button mounted on the throttle control is energized, the electromagnets of the valves are energized and the valves are set into position EXTENSION.

As a result, the side air brakes as well as the central air brake (when no tank is suspended) are extended.

When the button is set into the initial position, the electromagnets of the valves are de-energized and the valves are shifted to position RETRACTION. Hence, the air brakes are caused to retract.

In the extended and retracted positions the air brakes are retained by the fluid pressure.

When no pressure is built up in the system, the air brakes are retained in the retracted position by means of the check valve.

The thermovalve mounted inside the check valve releases the excess pressure of the working fluid caused due to an elevation of temperature in the course of operation of the aircraft.

To reduce the pressure of the return fluid, the operating lines are fitted with the throttles listed below:

(a) throttles of 1.8 mm dia. mounted into the valve connections are installed in the retraction and extension lines at the outlet of the ГА-184У valve of the side air brakes;

(b) throttles of 1.5 mm dia. similarly mounted into the valve connections are installed in the retraction and extension lines at the outlet of ГА-184У ventral air brake valve.

10. Air Brakes Control Units

Check Valve with Thermovalve (Fig.148)

The valve consists of body 1, cover 4, check valve 6 with spring 5, seat 3 and adjusting spring 7 with stop 2.

The valve is placed in the system so that the fluid delivered to the valves passes through the check valve.

When the pressure in the system is zero, the check valve is closed due to which the air brake system is cut off from the pressure line.

Inasmuch as the valve connects the retraction line with the pressure line when the brakes are retracted, the check valve opposes the fluid forced from the retraction line into the system, i.e., prevents spontaneous retraction of the air brakes during flight. When the pressure in the retraction cavities rises to 20 +5 kg/cm^2, the check valve together with the seat is caused to displace due to

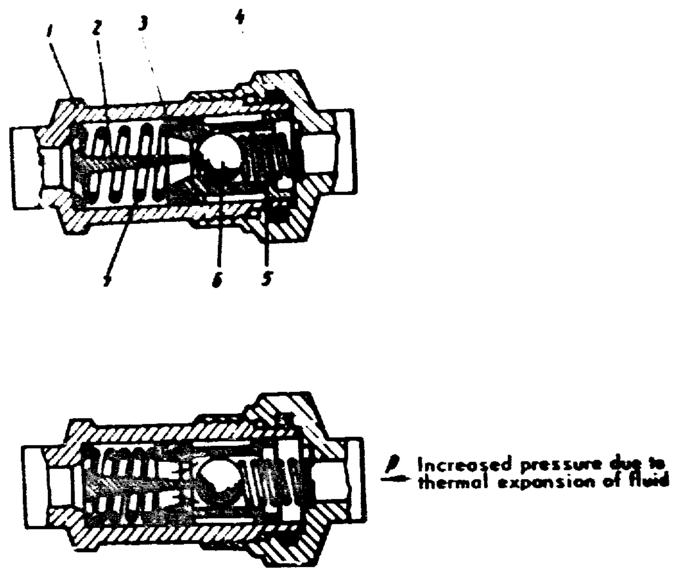

FIG.148. CHECK VALVE WITH THERMOVALVE
1 – body; 2 – stop; 3 – seat; 4 – cover; 5 – spring; 6 – ball; 7 – adjusting spring.

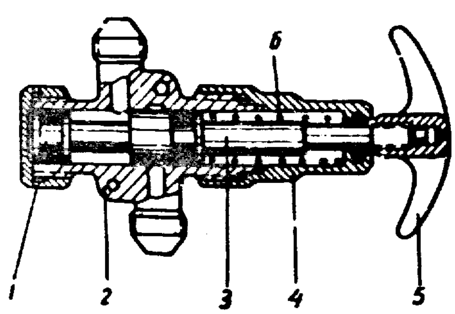

FIG.149. CROSS-FEED VALVE
1 – cover; 2 – body; 3 – rod; 4 – cover; 5 – handle; 6 – retracting spring.

the pressure which results in contraction of the adjusting spring. When the above pressure is built up, the valve ball hits the stop, and the excess pressure is relieved as a result.

If the system operates normally and the fluid expands due to heat inside the shut-off spaces, the valve opens when the pressure differential is 20 +5 kg/cm^2, i.e. the pressure at the valve outlet exceeds the pressure in the system by the value of the valve calibration. This prevents damage of the air brake cylinders.

Cross-Feed Valve (Fig.149)

The cross-feed valve is used for connecting the side air brake extension line with the retraction line during maintenance operations on the ground so as to prevent occasional closing of the air brakes leading to accidents when the personnel is engaged nearby the brakes.

The valve consists of body 2, retracting spring 6, rod 3, covers 1 and 4, and handle 5. The clearance between the rod and the body being 4 to 8 microns, excessive leaks of fluid between the air brake control lines are not possible.

The rod is hydraulically balanced. The lines are connected by means of pulling the rod out and setting a fork with a flag between the cover and the handle. Due to this, the initial closing of the connections effected by the slide valve shoulder is removed and the connections communicate through the slide valve central drilling.

The valve is located in the main wheel right-hand well.

The valve handle is painted red. The pulled-out rod is locked with a cotter pin with a flag.

ГА-184У Air Brake Valve

The operation of the ГА-184У valve is described in Section "Cone Control System".

Side Air Brake Cylinders (Fig.150)

The side air brake cylinders consist of inlet connections 1, cylinder cover 2, cylinder body 3, the rod of piston 4, locking slide block 5, eyebolt 6 and pipe 7.

A particular feature of the cylinders design lies in the fact that the fluid for retraction and extension is delivered through elbow connections 1 and through the interior ducts in the cover.

The pressure is delivered for retraction through pipe 7 connected to the welded retraction connections. Such design of the extended connections and of the elbow coupling of the connections installed outside the cylinder is ascribed to the extremely limited space at the place of cylinder attachment.

Ventral Air Brake Cylinder (Fig.151)

The design of the ventral air brake cylinder is analogous to that of the side air brake cylinder with the exception of the design of the elbow connections and availability of the universal joint.

The cylinder consists of body 4, cover 3 screwed on the body, shaft 2 with a connection, rod 5 with a piston welded into it, universal joint 1, locking plate 7, eyebolt 8 and pipe 6.

The fluid delivered for retraction is supplied through a respective connection, through a drilling in the shaft and through pipe 6 coupled to the retraction connection.

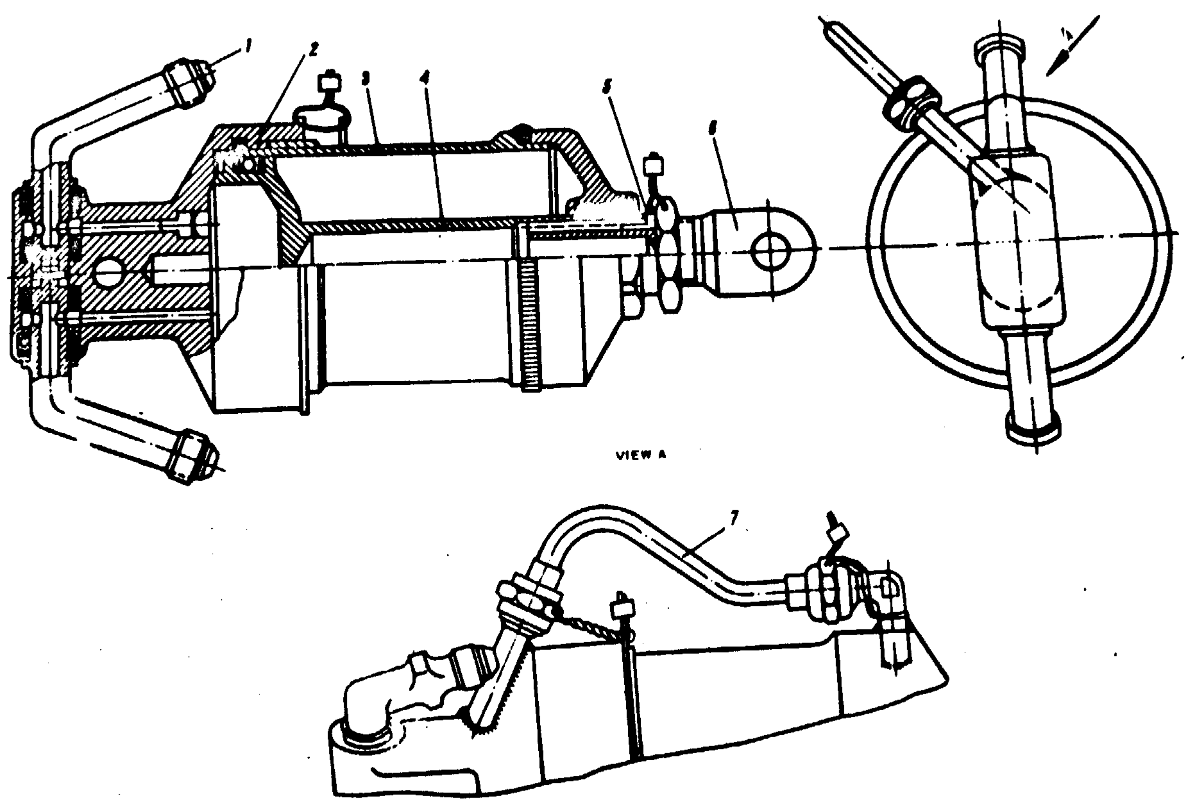

FIG. 1[illegible]. REAR AIR BRAKES CYLINDER
1 — pipe connection; 2 — cover; 3 — body; 4 — rod; 5 — locking slide block; 6 — eyebolt; 7 — pipe.

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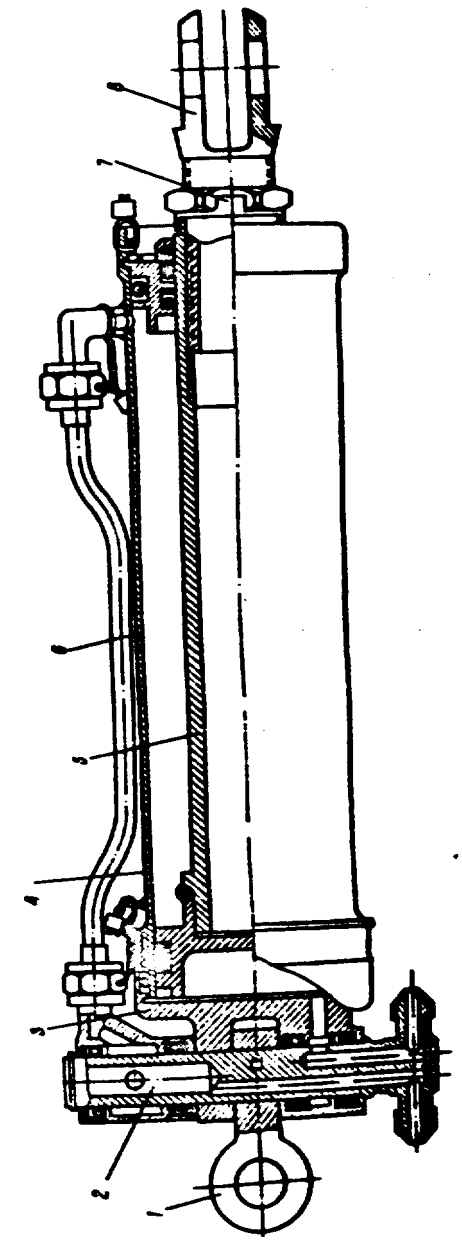

FIG.191. VENTRAL AIR BRAKE CYLINDER
1 – universal joint; 2 – shaft with pipe connection; 3 – cover; 4 – body; 5 – rod; 6 – pipe; 7 – locking plate; 8 – eyebolt.

 25X1

11. L.G. Control System (Fig.152)

The L.G. control system is designed to provide extension and retraction of the main and the nose struts of the landing gear as well as opening and closing the main strut doors.

The L.G. hydraulic control system consists of the following units:

(a) ГА-142/1 landing gear valve 30;

(b) three check valves 5;

(c) two sequence valves 36;

(d) three cylinders for L.G. extension and retraction 35 and 38 equipped with hydrolocks 34 and 40;

(e) two emergency valves 32;

(f) L.G. up-locks cylinders 39.

The landing gear ГА-142/1 valve is controlled by the pilot by means of a switch mounted on the instrument panel.

The switch has three positions: EXTENDED, RETRACTED and NEUTRAL.

The three positions of the switch correspond to the three respective positions of valve ГА-142/1.

When the switch is set into position EXTENDED the valve connects the extension line to the pressure line and couples the retraction line to the return line.

The fluid in the extension line is first supplied to the cylinders of the L.G. main struts up-lock, to the hydrolock and to the L.G. nose strut cylinder.

When the hydrolocks are open and the main wheels and the nose strut are unlocked, the fluid flows through the main strut lock opening cylinders to the hydrolocks of the main strut and then to the actuating cylinders as well as to the L.G. main struts doors. Thus, the strut doors are opened and the main struts are extended.

The nose strut is extended somewhat earlier because the fluid for extension of the nose strut is delivered simultaneously to the hydrolock and to the strut actuating cylinder.

The L.G. main struts are retained in the extended position by means of the actuating cylinders inner mechanical locks and hydrolocks while the nose strut is retained thereat by means of the stop and hydrolock.

With the L.G. extended for landing, the switch remains in position EXTENDED as long as the landing roll is performed and the aircraft is placed to a parking place, after which the switch is changed over to position NEUTRAL and locked by a retainer.

When the switch is set into position RETRACTED, the ГА-142/1 valve connects the retraction line to the pressure line and couples the extension line with the return line.

The pressure causes the fluid to pass to the main strut hydrolock and to the automatic brake cylinder.

Simultaneously, the fluid is delivered to the L.G. main struts hydrolocks, to the up-lock cylinders and to the sequence valves. In this case the up-lock cylinders are set to the initial position so that the locks are allowed to fix the struts as they are retracted to be locked.

From the hydrolocks the fluid comes to the actuating cylinders and the three struts are retracted. At the end of the retraction cycle the levers of special design mounted on the main struts press upon the rods of the sequence valves through which the fluid is delivered for retraction of the main strut doors when the rods are depressed.

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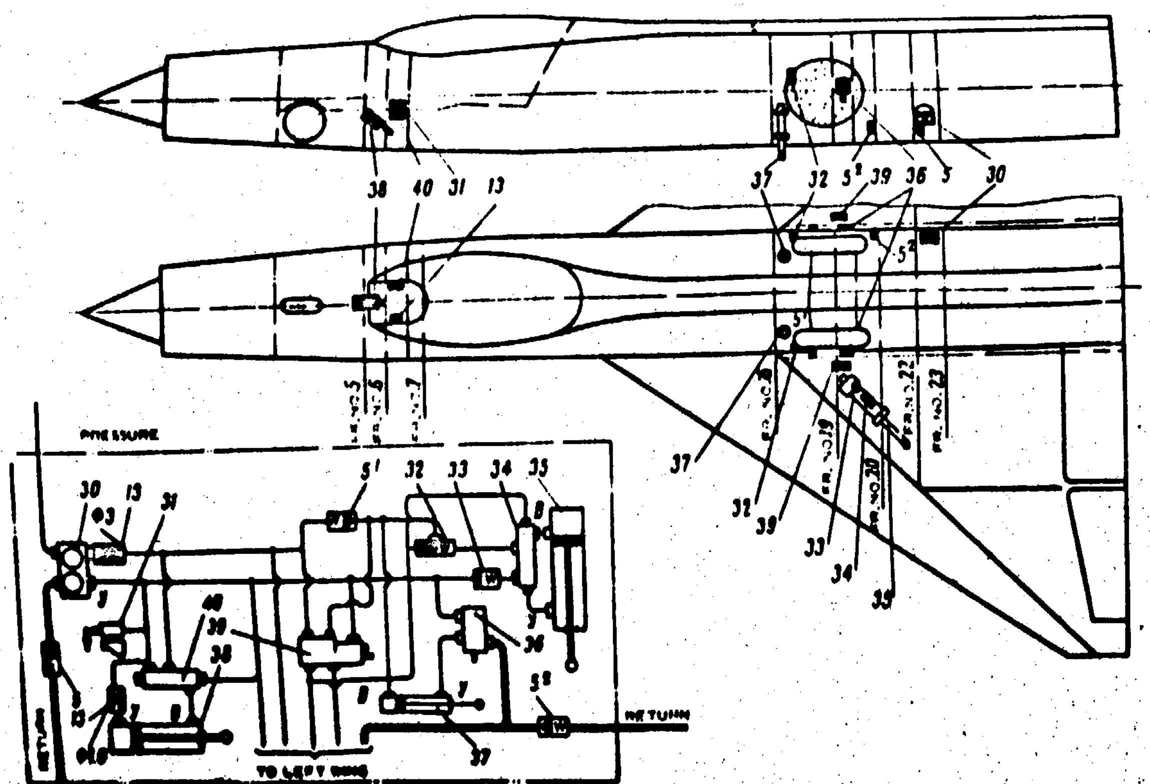

FIG.1[illegible]. L.G. CONTROL SYSTEM (Reference numbers are as in Fig.122)
5 – check valve (5¹, 5²); 13 – [illegible]; 30 – ГА-142/1 valve; 31 – pneumatic brake cylinder; 32 – emergency valve; 33 – one-way throttle; 34 – L.G. main strut actuating cylinder hydrolock; 35 – L.G. main strut actuating cylinder; 36 – sequence valve; 37 – L.G. main strut wheel door cylinder; 38 – nose strut actuating cylinder; 39 – L.G. main strut uplock cylinder; 40 – L.G. nose strut actuating cylinder hydrolock.

When the up-lock cylinders are set into the initial position, the retraction line which in this case serves as a return line is cut off. Hence, the fluid is returned through the check valve and the cross-feed line of the up-lock cylinder.

When a pressure is applied to the automatic brake cylinder during retraction of the L.G., the cylinder pushes the lever of ПУ-7 brake valve and effects the braking of the L.G. wheels.

When the valve is set into position NEUTRAL, the extension and retraction lines are connected to the return line.

To reduce the pressure of the return fluid, the ГА-142/1 valve is mounted in the extension line and a throttle, dia. 3 mm, is fitted into the valve connection.

In order to prevent abrupt extension of the struts under their weight at the instant of extension, the lines are fitted with the throttles given below:

throttle, dia. 1.6 mm, built into the nose strut steel elbow;

one-way throttles, dia. 1.2 mm., installed in the main struts.

To prevent the affects of the return pressure in the system which are caused during operation of the air brakes and may lead to unlocking of the L.G. actuating cylinders retained by the mechanical locks, a check valve built into the ГА-142/1 valve return connection is fitted into the return line at the ГА-142/1 valve outlet.

The struts are retained in the retracted position by means of the up-locks.

After the L.G. is retracted, warning lamp L.G. RETRACTED lights up. The switch should be set into position NEUTRAL and locked by a retainer.

After extension of the L.G., warning lamp L.G. EXTENDED lights up on the warning panel.

In case the main hydraulic system fails, the landing gear can be extended by means of compressed air.

With an emergency extension of the landing gear, the emergency L.G. extension valve mounted on the right-hand console the cockpit is to be opened, due to which the air at 110 to 130 kg/cm^2 is fed from the emergency air bottles through the return valve to main strut lock-up cylinders 39. After the up-locks of the main struts and the locks of the main struts doors are opened, the air for extension of the doors is supplied through emergency valves 32 while the air for extension of the L.G. is delivered through hydrolocks 34. To extend the nose strut the compressed air is fed directly to hydrolock 40, passes through it and operates strut actuating cylinder 38 to extend the strut.

After an emergency L.G. extension, the following operations should be performed:

1. Open and lock the emergency valve.

2. Release the air from the emergency L.G. extension system, disconnect the main and nose struts oil delivery pipes within the sections between the hydrolocks and the cylinders and disconnect the pipes coupling the main strut doors emergency valves to the extension line. After the air is completely exhausted, connect the pipes and lock them (Fig.124).

3. Connect a ground hydraulic pump and perform 10 to 12 cycles for the L.G. retraction and extension so as to remove the air remaining inside the hydraulic system. Check the airtightness of the joints.

4. Make sure that the L.G. up-locks are in good condition.

CAUTION! Never retract the landing gear before the air is released from the cylinders system after using the emergency extension system.

12. L.G. Control Units

ГА-142/1 L.G. Valve (Fig.153)

The ГА-142/1 valve is a three-position electromagnetic servovalve.

The valve consists of two electromagnetic ball valves 5, distribution slide valve 10, plungers 3 and bushes 2 with springs 4, which are housed in body 1 made of aluminium alloy.

The valve is provided with buttons for manual control.

When the electromagnets are de-energized, the valve balls are pressed to the seats. The right and left cavities of the distribution slide valve are connected to the pressure line and the slide valve is retained in the neutral position due to action of the springs. Both outlet connections are connected to the return line.

When the left-hand electromagnet is cut in, the electromagnet core shifts and presses ball 5 to the seat. In this case the cavity on the left side of the distribution valve communicates with the return line and the right-side cavity communicates with the pressure line.

As the pressure is applied to the right-hand plunger, it shifts slide valve 10 to the extreme left-hand position.

The right-hand bush remains in place since it rests against the body.

The left-hand plunger and the bush travel together with the slide valve to the extreme left-hand position until the right-hand bush rests against the body.

In this case the left-hand connection communicates with the pressure line and the right-hand connection communicates with the return line.

When the left-hand electromagnet is de-energized, the pressure causes the valve ball to shift from the seat and the cavity on the left side of the slide valve communicates with the pressure line.

The slide valve starts returning to the neutral position due to action applied to it by the left-hand bush acted upon by the spring. As a result, the amounts of pressures applied are balanced.

The slide valve stops as soon as the left-hand bush reaches the rest in the body.

Cavity PUMP is closed thereby and the outlet connections communicate with the return line.

When the right-hand electromagnet is energized, the right-hand cavity communicates with the return line and the left-hand cavity remains connected with the pressure line. The right-hand connection communicates with the pressure line and the left-hand connection is coupled to the return line.

The operation of the unit is analogous to the operation performed when the left-hand electromagnet is energized.

When the right-hand electromagnet is cut off, the slide valve is similarly set in the neutral position.

When the pressure is zero and the electromagnet is de-energized, the slide valve is set in the neutral position by springs 4.

To engage the unit manually, the safety caps should be removed and the button depressed sharply, but without striking. Simultaneously, the motion is imparted to the magnet tappet to operate the ball valve.

In this case the right-hand button acts instead of the right-hand electromagnet and the left-hand button acts instead of the left-hand electromagnet.

Installed in the valve outlet line is a 3 mm. dia. throttle connection.

The seat of the RESERVOIR body is fitted with a check valve which consists of a ball, slide, spring and a body with a cover.

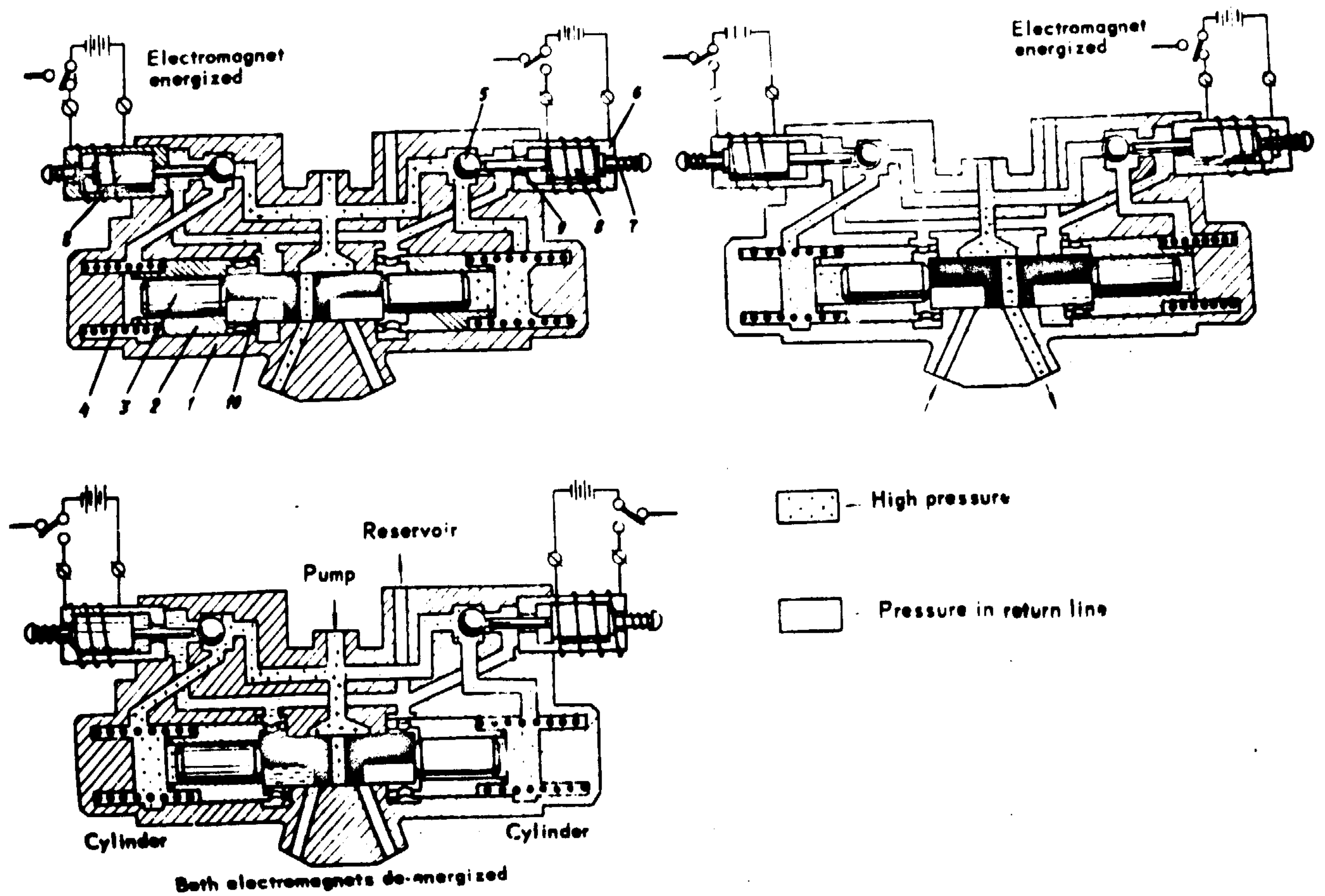

FIG.155. L.G. VALVE ГА-142/1
1 — body; 2 — bushing; 3 — plunger; 4 — spring; 5 — ball valve; 6 — coil housing; 7 — manual control button; 8 — core; 9 — tappet; 10 — slide valve.

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The check valve allows the fluid passage from the valve and prevents spreading of pressure in the return lines of the system into the L.G. control system.

L.G. Main Struts Up-Lock Cylinder (Fig.154)

The up-lock cylinder of the L.G. main struts is made integral with the emergency unlocking cylinder so that they are housed inside a common body. The description of the emergency unlocking cylinder is given in Section "Air System".

The up-lock cylinder of the L.G. main struts consists of body 3, rod 4 with adjusting screw 1 and locknut 2, and stationary plunger 5.

The cylinder rod is hydraulically balanced, i.e. the area of the rod piston in cavity RETRACTION is equal to the area of the rod piston in cavity EXTENSION. This has been achieved by virtue of using a stationary plunger mounted in the system so that the rod travels along the stationary plunger when it returns from the extension line side. The diameters of the plunger shaft and of the cylinder rod are equal.

This prevents occasional operation of the cylinder when a pressure is built up in the two cavities after the ГА-142/1 valve is set into the neutral position (i.e. when a pressure is built up in the return line).

There are three connections for coupling the body to the system, namely one connection for the retraction line and two for the extension line.

The cylinder rod is mounted into the cylinder so that the clearance between them is small which reduces fluid leakage when extending the L.G.

When a pressure is delivered to the extension line, the fluid acts on the rod and displaces it until the up-locks are opened. Meanwhile the pressure is not supplied to the other units in the L.G. main struts extension line. After the rod is extended, a passage for the fluid to be supplied to the second extension connection is formed so as to feed the fluid to the door cylinders and the actuating cylinder hydrolock to continue the extension cycle.

Thus, the interlocking of the extension is accomplished which implies that the pressure for extension of the L.G. main struts is not delivered to the L.G. actuating cylinder as long as the strut is retained by the up-lock.

The nose strut has its own interlocking system which utilises the initial extension travel of the strut actuating cylinder to open the up-lock when the strut is in the retracted position.

When the pressure causes the rod to return to its initial position during retraction and disconnects the extension ports which at this instant serve as the return line, the fluid is returned from the extension cavity of the L.G. actuating cylinder and passes through a special cross-feed line equipped with a check valve.

The lock cylinders are located together with the up-locks on wing rib 1.

L.G. Hydrolock (Fig.155)

The hydrolocks of the main and nose struts are similar in design and differ only in the configuration of the connections.

The hydrolock consists of bodies 1 and 4, connecting nut 2, sleeve 7, valve 8 with a thermovalve, emergency extension valve 11, piston 3 with tappet 5 and retracting spring 6.

The hydrolock is intended to trap the fluid inside the extension cavity of the actuating cylinder which prevents folding (retraction) of the main struts in case the actuating cylinder mechanical locks fail to operate.

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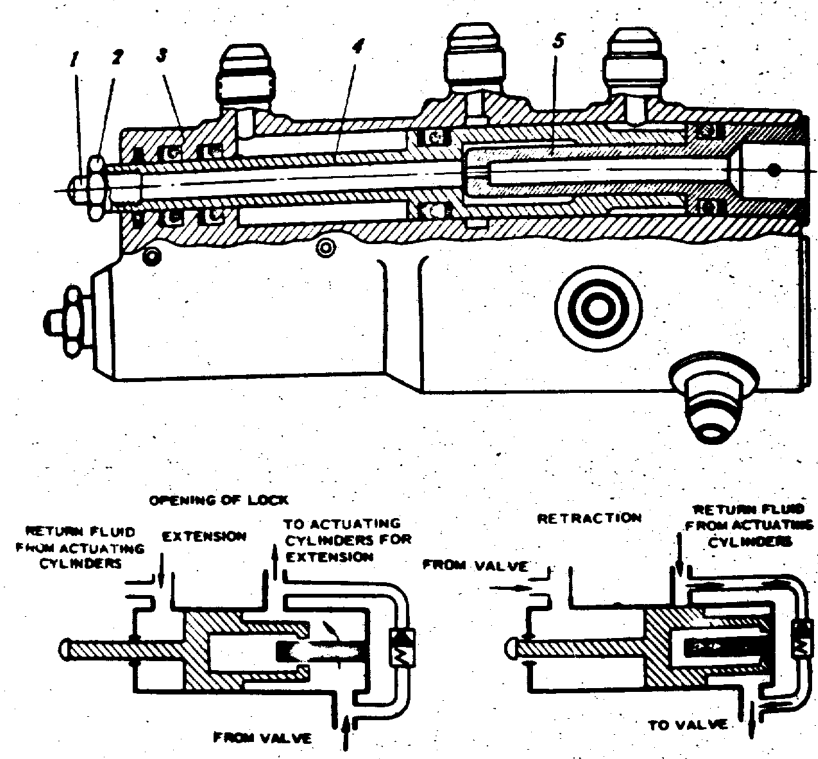

FIG.154. L.G. MAIN STRUTS UP-LOCK CYLINDER
1 – adjusting screw; 2 – locknut; 3 – body; 4 – rod; 5 – plunger.

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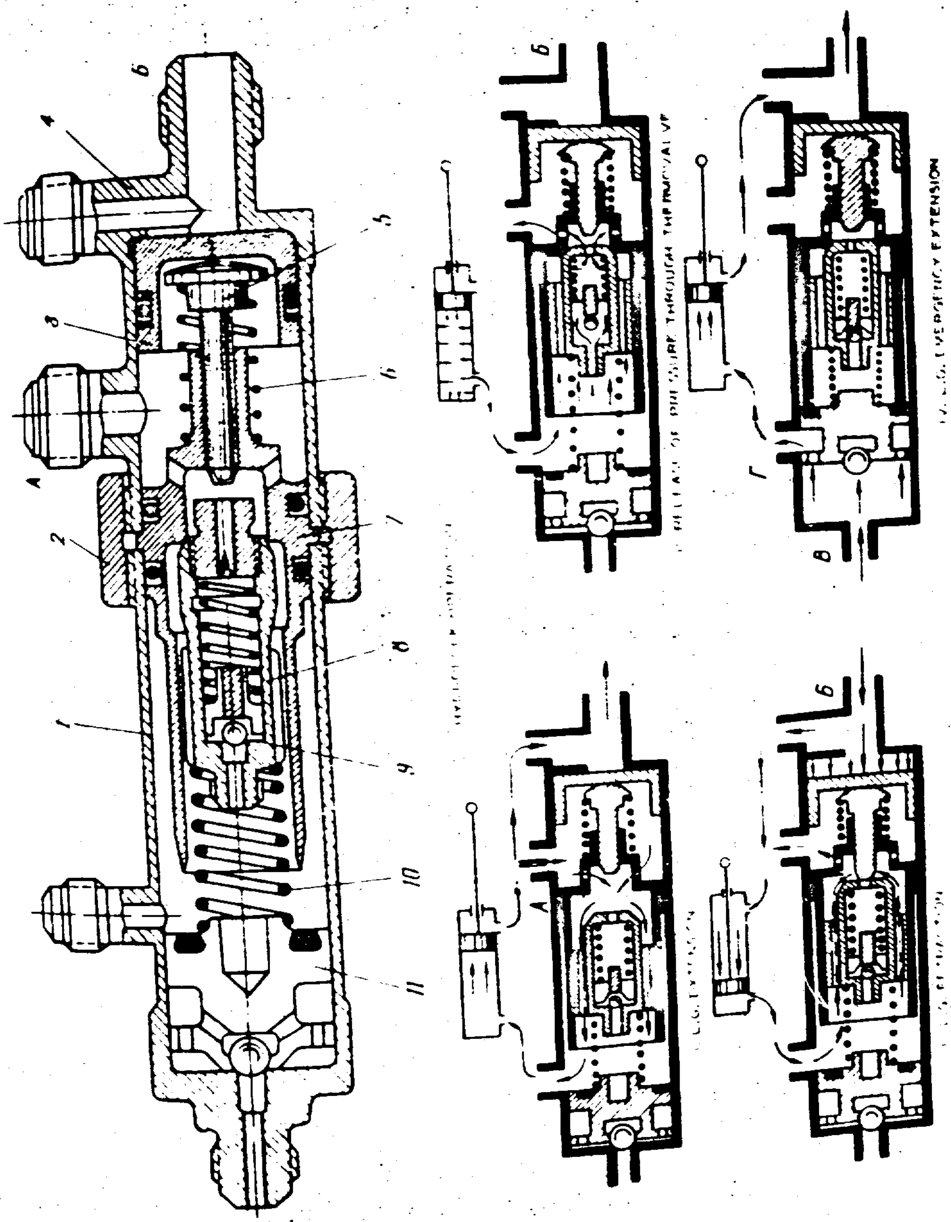

FIG.155. L.G. HYDRAULIC LOCK

1 – body, 2 – connecting nut, 3 – piston; 4 – body, 5 – tappet, 6 – retracting spring, 7 – sleeve; 8 – thermovalve; 9 – thermovalve 10 – retracting spring, 11 – emergency extension valve

When the pressure is delivered to the extension line, the fluid supplied to connection A gets inside the cavity of body 4. Then the fluid causes the valve with the thermovalve to move aside, flows through the outlet connection to the actuating cylinder and effects the extension of the strut wheel.

When the extension is over and the pressures at the inlet and outlet of the valve become equal, retracting spring 10 displaces the valve with the thermovalve to the seat so that a certain quantity of fluid inside the actuating cylinder extension cavity is trapped.

When the L.G. struts are retracted, the fluid delivered to connection B shifts the piston and the tappet into the extreme left-hand position. Meanwhile the tappet displaces the valve with the thermovalve aside and thereby opens a passage for the fluid to pass from the extension cavity to the return line. After the retraction is over, when the L.G. control is set into position NEUTRAL, the piston retracting spring returns the tappet and the piston into the initial position while the respective spring moves the valve with the thermovalve to the seat.

In the case of thermal expansion of the fluid trapped inside the valve cavity, the pressure is released through the thermovalve built into the hydrolock valve.

Thermovalve 8 consists of ball 9, a rest and a spring with a nut. The thermovalve is calibrated to open at pressure 275 kg/cm^2.

The nut is locked due to springing action of the threaded portion of the nut which has an axial cut and a subsequent slack of the slot.

When the L.G. is extended on emergency, the compressed air delivered to connection B displaces emergency extension valve 11 to the seat formed by the butt end of the sleeve. In this case the air passes through connection Γ and extends the strut while the tightness of joint between the air cavity and the hydraulic system is provided through the close contact between the butt end of the emergency extension piston and the butt end of the sleeve.

When the air is released from the emergency extension line, the emergency extension valve is set into the seat of body 1 by the retracting spring.

The main struts hydrolocks are mounted on the actuating cylinders and the nose strut hydrolock is installed inside the nose strut well.

Nose Strut Actuating Cylinder (Fig.156)

The actuating cylinder consists of upper cover 2, hinge attachment fitting 1, sleeve 4, rod 5 with eyebolt 7 and a locknut, and lower cover with a fixing nut.

The cylinder serves for extension and retraction of the L.G. nose strut.

The kinematic system of the nose strut and the attachment of the cylinder to the strut provide for retraction of the rod during extension and vice versa.

Inasmuch as the pressure is delivered to the extension and retraction cavities through the hinge attachment fitting 1 of the cylinder, no flexible pipelines are required.

L.G. Main Strut Wheel Door Cylinder

The L.G. main strut wheel door cylinder is similar in design to the actuating cylinder of the nose strut. The door cylinders are installed in the right and left wells of the wheels.

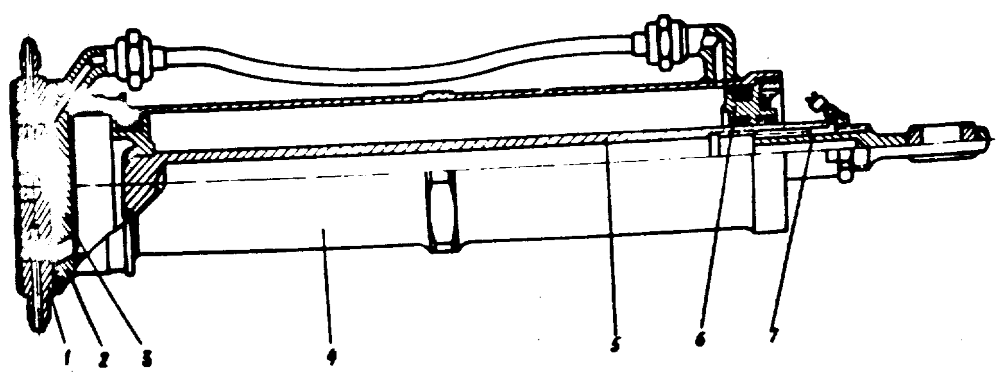

FIG.156. L.G. NOSE STRUT ACTUATING CYLINDER

1 – attachment hinge; 2 – upper cover; 3 – hinge attachment universal joint; 4 – sleeve; 5 – rod; 6 – cover; 7 – eyebolt.

Sequence Valve (Fig.157)

In order to prevent a breakdown of the main strut wheel doors during retraction, it is necessary that wheel retraction and closing of the doors should follow one another in a definite sequence.

A priority (or sequence) of retraction of the struts and doors is provided by the sequence valve built into the cylinder door retraction line. The sequence valve consists of body 3, check valve 4, spring 2, rod 5 with retracting spring 6 and adjusting screw 8. When the pressure is supplied for retraction, the fluid is delivered to connection A and fed to the strut actuating cylinders and the doors cylinders. The main struts start to retract but the fluid is not supplied to the doors cylinders since the passage to the cylinder retraction cavity is cut off by the check valve. When the struts are fixed by the up-locks, the strut cylinder pushes a lug of special design which in turn pushes the piston of the sequence valve so that the piston displaces the check valve. Due to this the fluid passes into the retraction cavity of the L.G. doors cylinders and causes the doors to retract and close the L.G. wheels.

When the L.G. struts are extended, the rod is set into the initial position by retracting spring 6 and the check valve sinks into its seat. But inasmuch as the fluid fed from the retraction cavity to the return line flows in the opposite direction, the check valve does not oppose the flow.

If the valve is leaky and the fluid is not drained, the door can be retracted partially which may lead to a breakdown. To avoid this, the body is provided with connection B connecting the body to the return line. The fluid which penetrates through the closed valve is drained to the return line through a drain pipe and does not cause retraction of the door.

When the strut presses the rod, it causes the rod to displace and cut off the drain port and after the valve is open the fluid cannot pass to the return line but is routed to the L.G. door retraction line.

L.G. Main Strut Actuating Cylinder (Fig.158)

The main strut actuating cylinder is designed for extension and retraction of the main struts. When the cylinder is extended, it serves as a load-carrying strut brace and prevents folding of the strut by the mechanical lock fitted into the cylinder.

The fluid is delivered to the extension and retraction lines through the cylinder universal joint and then along the pipelines feeding it to the body connections of the extension and retraction cavities. Installed directly on the actuating cylinder is L.G. hydrolock 5 which is secured to the cylinder by means of a clamp. The hydrolock is connected to the extension and retraction lines.

The extension and retraction cycles are accomplished as follows:

When pressure is fed to the extension line, the fluid passes through the universal joint and its axles, enters the hydrolock and is further delivered into the extension cavity. As the pressure of the fluid is applied to the surface of the rod piston, the rod is caused to displace.

The rod piston comprises the mechanical lock which consists of expansion ring 12 and locking bush 9 with a spring. The mechanical lock operates as follows. When the rod moves for extension or is set to the retracted position, the expansion ring is compressed, the bush is displaced aside and the spring is stressed.

At the instant when the rod reaches the stop while extending, the expansion ring is aligned with a groove in the body so that it enters the groove while expand-

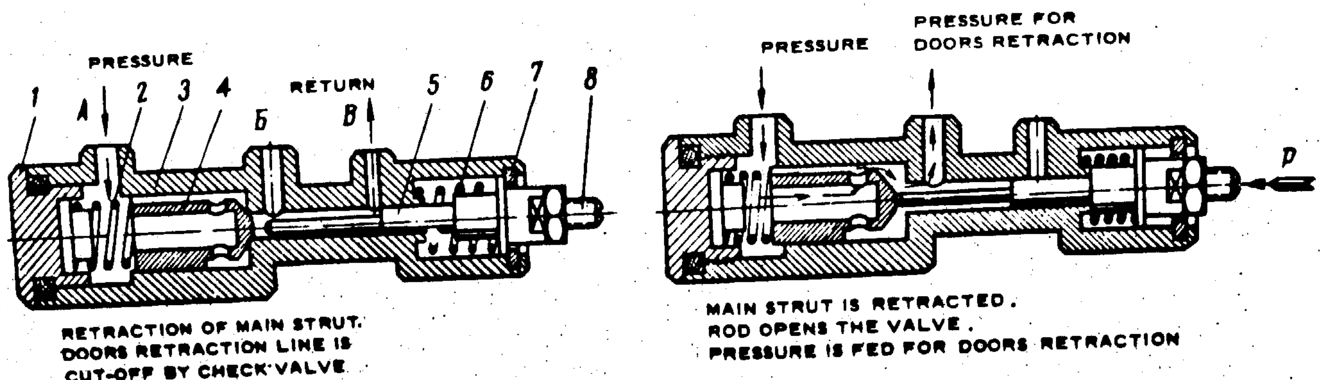

FIG.157. SEQUENCE VALVE

1 – cover; 2 – spring; 3 – body; 4 – check valve; 5 – rod; 6 – retracting spring; 7 – stop; 8 – adjusting screw.

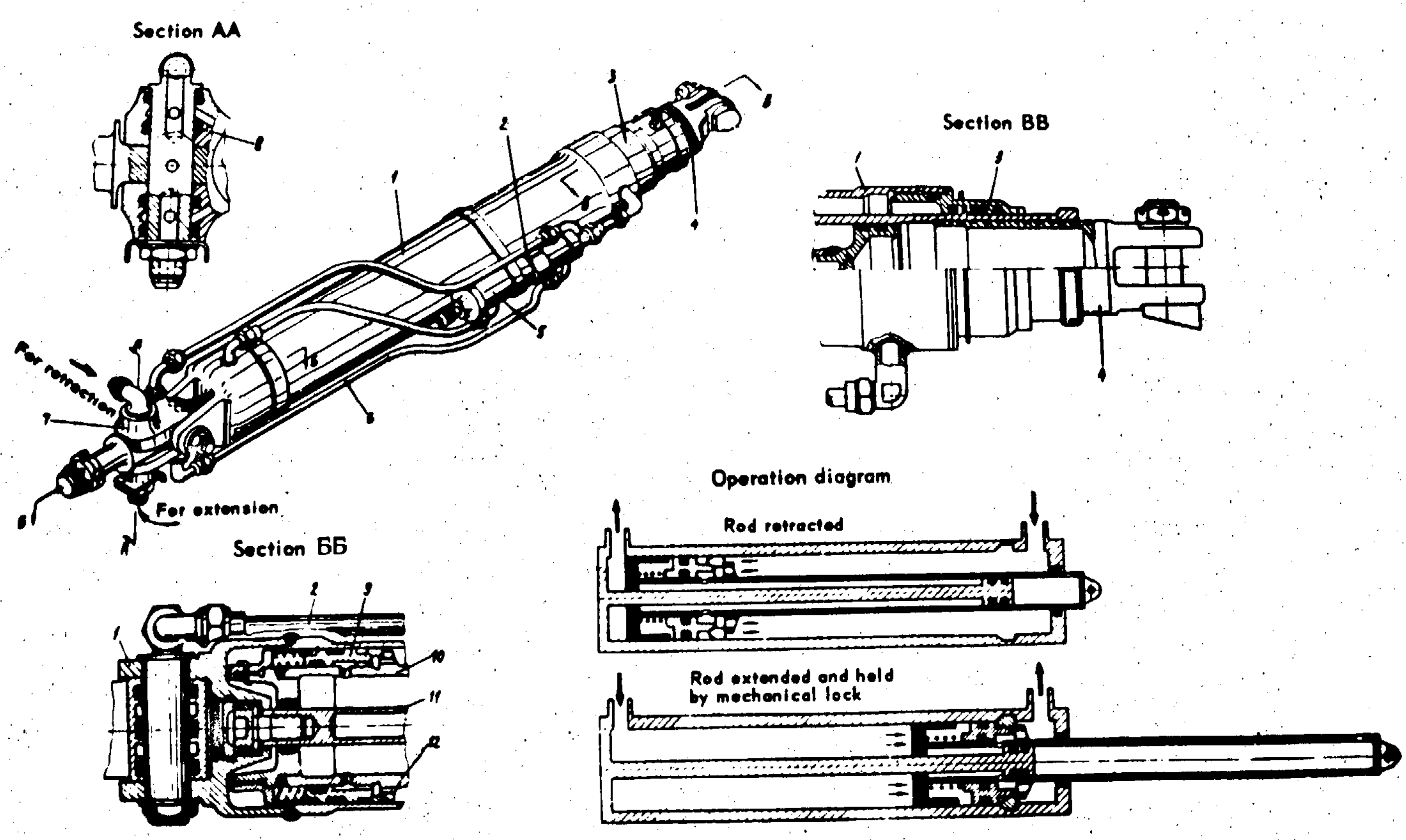

FIG.158. L.G. MAIN STRUT ACTUATING CYLINDER
1 – cylinder sleeve; 2 – retraction line pipe; 3 – lower cover; 4 – eyebolt; 5 – hydrolock; 6 – extension line pipe; 7 – attachment assembly; 8 – universal joint; 9 – locking bush; 10 – rod; 11 – inside piston; 12 – expansion ring.

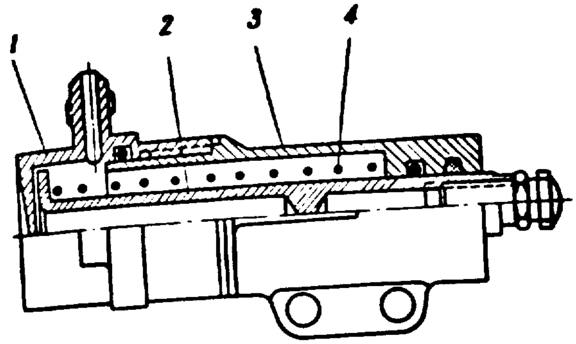

FIG.159. AUTOMATIC BRAKE CYLINDER
1 – cover; 2 – rod; 3 – body; 4 – retracting spring.

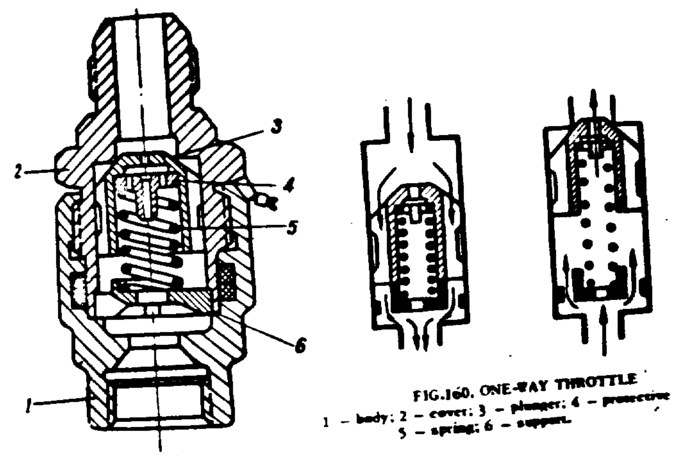

FIG.160. ONE-WAY THROTTLE
1 – body; 2 – cover; 3 – plunger; 4 – protective gauze;
5 – spring; 6 – support.

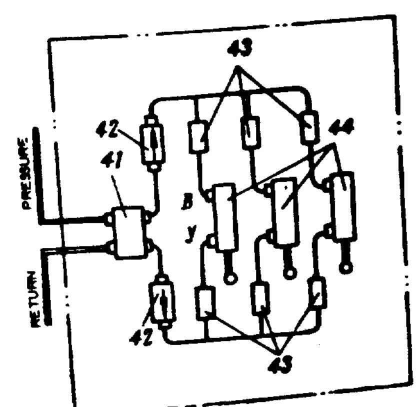

FIG.161. ENGINE NOZZLE FLAPS CONTROL SYSTEM (Reference numbers are as in Fig.122)
41 – nozzle flaps valve ГА-164М/1; 42 – ГА-173 metering unit; 43 – synchronizing valves;
44 – afterburner flaps ring cylinders.

ing. As the bush is acted by the spring and by the pressure, it moves to the right, and fits into a position just under the expansion ring due to which the ring is locked inside the groove. Hence, the lock is fixed. When an axial load is applied for retraction, the rod cannot move since its lug rests against the ring locked inside the groove.

During retraction, the fluid pressure causes the bush to displace to the left, move from under the expansion ring and release the ring. While the rod is shifted for retraction, the expansion ring contracts against the body groove bevels till its diameter is equal to the diameter of the cylinder so that the rod is allowed to retract.

The internal assembly of the piston allows the diameter of the cylinder rod to be increased without reducing the piston area inside cavity RETRACTION.

Automatic Brake Cylinder (Fig.159)

The automatic brake cylinder is installed in the L.G. retraction line.

It is designed to depress the lever of the ПУ-7 valve and thereby provide the braking of the wheels during retraction.

The cylinder consists of body 3, cover 1 and rod 2 with retracting spring 4.

When pressure is fed to the retraction line, the fluid supplied causes the rod to extend, displace the ПУ-7 valve lever and effect the braking.

When the ГА-142/1 valve of the landing gear is set into position NEUTRAL, the spring displaces the rod into its initial position and the wheels are released through the ПУ-7 valve. The adjusting screw is set into a position where a pressure of 3 to 4 kg/cm^2 is built up in the brake system when the ПУ-7 valve operates. The cylinder is installed behind the control column in space between frames Nos 6 and 7.

One-Way Throttle (Fig.160)

The one-way throttle retards the fluid flow in one direction and allows the fluid to pass freely in the other direction.

The operation of this kind is provided by the use of a check valve which has a small port in plunger 3 interconnecting the inlet and outlet connections.

When the pressure is applied in the direction opposite to that indicated by the arrow on the body, the fluid can travel through the calibrated port so that the velocity of fluid is considerably reduced.

When the fluid travels in the backward direction, the pressure acting on the plunger compresses retracting spring 5 and displaces the plunger so as to allow the fluid to pass freely through the throttle.

The one-way throttles installed in the main strut retraction line are designed to retard the fluid drained from the actuating cylinders retraction cavities at the instant of extension and thereby ensure a smooth travel of the struts during extension. When the L.G. is retracted, the throttles do not affect the speed of retraction because no retardation of the fluid moving in this direction is caused.

The one-way throttle consists of body 1, cover 2, plunger 3, spring 5, support 6 and protective screen 4.

13. Engine Nozzle Flaps Control System

The engine nozzle flaps are controlled automatically by means of changing the position of the engine control lever. The nozzle flaps hydraulic system comprises ГА-164М/1 hydraulic valve 41 and ГА-173 metering units 42. From the metering units the pipeline runs to the hydraulic manifold of the engine. Nozzle flaps actuating cylinders 44 and synchronizing valves 43 are also connected to the manifold.

The nozzle flaps actuating cylinders and the synchronizing valves are mounted on the engine and form a part of the engine set.

The jet nozzle flaps follow the displacement of the engine control lever within the range from the minimum to the maximum augmentation ratings. The flaps are completely open within the range from the engine idling rating to $n = 66^{+2}_{-1}$ per cent of the high-pressure rotor speed.

In case the all-duty jet nozzle control system fails to operate, a two-position jet nozzle control system can be employed by cutting in switch EMERGENCY NOZZLE CONTROL, due to which the follow-up system is switched-off. In this position of the engine control lever within the range from the engine idling rating to $n = 60^{+1}_{-2}$ per cent of the high-pressure rotor speed, the nozzle flaps are completely open. When the lever is further shifted, the flaps close up completely and then open their full way only at full augmentation rating. When the lever is shifted in the opposite direction, the modes of engine operation are changed in the reverse succession.

The ГА-173 metering units fitted in the retraction and extension lines between the ГА-164М/1 valve and the cylinders, are designed to allow certain quantities of fluid to pass to the cylinders and to lock the system in the event of damage of the pipelines. The fluid delivered in the opposite direction passes freely through the metering units.

14. Engine Nozzle Flaps Control Units

ГА-164М/1 Valve (Fig.162)

The ГА-164М/1 valve is a combination of a three-position electromagnetic valve and a two-way hydraulic lock provided with thermal valves.

The valve is intended to control the cylinders of the engine nozzle flaps by means of delivering the compressed fluid into the retraction and extension cavities and locking the fluid inside the cylinders in any intermediate position.

In order to protect the cylinders and the system from the thermal expansion of the fluid trapped inside the cavities, the valve is equipped with thermal valves.

The valve consists of body 1 made of aluminium alloy, a two-way hydraulic lock, a hydraulic distributing unit comprising two ball valves 2, two electromagnets, two retracting springs 3 and two thermal valves 8.

In the course of operation the ГА-164М/1 valve can be set into the following positions:

I. When the electromagnets are de-energized, distributing valves 2 are depressed by springs 3 to bushing seats 4 so that the supply of fluid to the cylinder from the high-pressure line is cut-off.

In this position the two-way hydraulic lock is closed, i.e. balls 5 are driven into the seats of stationary bushings 6 and change-over piston 7 is set into the neutral position.

The fluid is trapped in the cylinder extension and retraction cavities.

II. When the voltage is applied to the right-hand electromagnet and the magnet core is caused to displace, the right-hand distributing valve moves to the left so that the spring is compressed. The valve is set in a position in which the right-hand cavity of the valve is coupled to the pressure line and disconnected from the return line.

The fluid presses off the ball of the hydraulic lock and enters the cylinder extension cavity. Simultaneously the fluid displaces the change-over piston which

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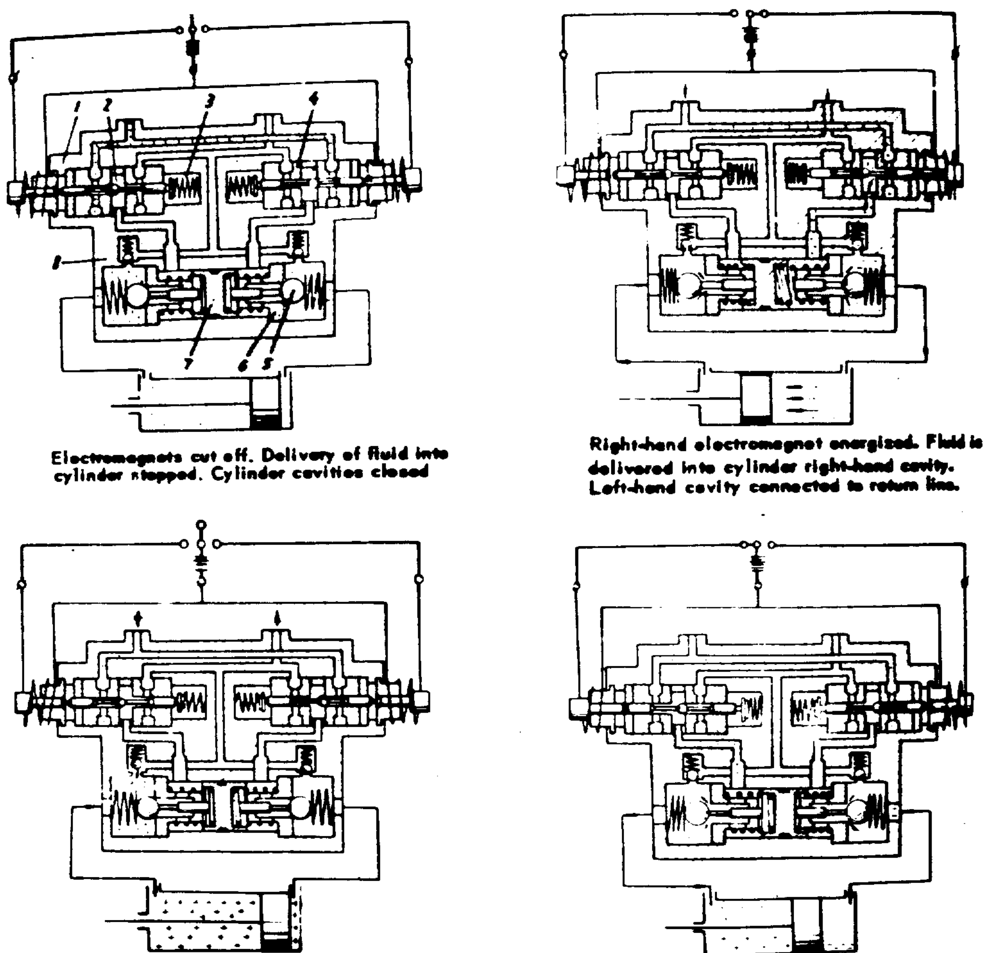

Electromagnets cut off. Delivery of fluid into cylinder stopped. Cylinder cavities closed

Right-hand electromagnet energized. Fluid is delivered into cylinder right-hand cavity. Left-hand cavity connected to return line.

Electromagnets cut off. Pressure in cylinder left-hand cavity exceeds working pressure. Thermal valve operates.

Left-hand electromagnet energized. Fluid is delivered into cylinder left-hand cavity. Right-hand cavity connected to return line.

FIG.162. ГА-164М VALVE
1 – body; 2 – ball valve; 3 – spring; 4 – bush; 5 – ball; 6 – bush; 7 – piston; 8 – thermovalve.

acts with its tappet upon the other ball of the hydraulic lock and displaces it so that the fluid inside the return cavity is drained when the rod is being extended.

III. When the left-hand electromagnet is cut in, the left-hand distributing valve operates in a way similar to that described above. The fluid is delivered for retraction of the rod and is returned from the extension cavity through the lock ball opened by the piston.

After the coil is de-energized, the distributing slide valve is immediately forced into the seat due to the action of the spring and the valve is set into the initial position described above in Point I.

IV. In the case of thermal expansion of the fluid, the pressure is released through thermal valve 8 whose internal cavities are connected to the return line. The pressure at which the thermal valves open is equal to 240 +10 kg/cm^2.

ГА-173 Metering Unit (Fig.163)

The ГА-173 metering unit is intended to cut off a damaged portion of the pipelines by means of locking the fluid supply ducts after a certain quantity of fluid has been passed by.

The ГА-173 metering unit consists of the following parts: body 1, stop 2, sleeve 3, slide valve 5, valve 7 of floating valve 9, seat 11 and diaphragm 12.

The sleeve has rubber packing ring 6 which separates cavities A and Б of the unit. Screwed into the bottom of the body and into the cover are pipe connections.

Diaphragm 12 can shift axially a small length of 0.3 to 0.4 mm.

When the fluid enters the unit through orifice B, the diaphragm is pressed closely to seat 11 so that only a calibrated hole is made to allow fluid passage into cavity Г between valve 9 and seat 11.

When the fluid is supplied in the opposite direction, the diaphragm is caused to displace away from the seat, and the passage area is thereby increased. A certain quantity of fluid is returned only in case the pressure is applied to orifice B. Then a definite quantity of fluid is drained through orifice Д after which the passage of fluid is cut off by valve 9.

The fluid supplied through the metering unit in the opposite direction passes freely.

The method employed in the unit consists in the following:

The fluid delivered to pipe connection B passes from cavity A to E through calibrated orifices K of sleeve 2.

The fluid pressure upon slide valve 5 displaces it into the extreme left-hand position and a passage is made to pass the fluid through orifices H into cavity Б and furtheron through the orifices of stop 2 into pipe connection Л.

When the fluid is delivered through orifices K a certain pressure differential is made between cavities A and E which is equal to the difference of pressures P_1 and P_2.

A similar pressure differential is created on the two sides of diaphragm 12.

The right side of diaphragm 12 is acted upon by pressure P_1 and the left side is acted by P_2 similarly as in cavity E because the weight of valve 9 is approximately equal to the weight of fluid displaced by the valve and also because the valve is almost frictionless. Due to the pressure differential, cavity Г is filled and valve 9 is caused to displace from right to left.

After the diaphragm admits the quantity of fluid required to cause the complete travel of the valve, the valve sinks on the sleeve seat and cuts off the passage of the main portion of fluid delivered through the valve.

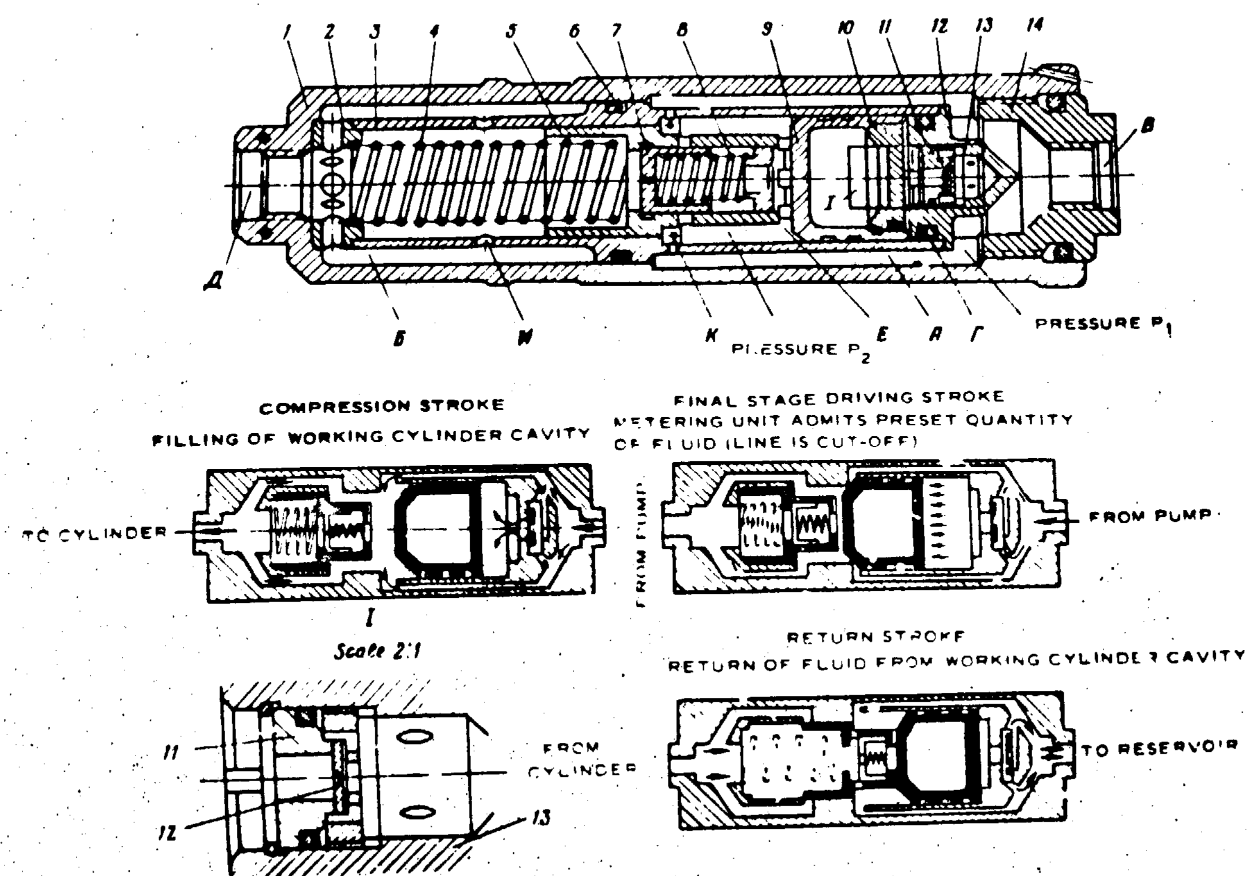

FIG.163. [illegible] METERING UNIT

1 — body; 2 — stop; 3 — sleeve; 4 — spring; 5 — slide valve; 6 — packing ring; 7 — valve; 8 — spring; 9 — floating valve; 10 — valve bottom; 11 — guard; 12 — diaphragm; 13 — sleeve cover; 14 — cover.

No matter what the consumption of fluid delivered through the unit may be, the pressure differential remains constant for orifices K and the diaphragm though the magnitude of the pressure may vary.

Therefore, the ratio between the volumes of fluid supplied through orifices K and the diaphragm is a constant whatever the consumption of fluid may be.

But since the quantity of fluid supplied through the diaphragm prior to closing of valve 3 is invariably the same and equals the product of the valve cross-sectional area by the value of the valve stroke, the quantity of fluid supplied through orifices K and, hence, through the whole metering unit, is constant.

When the fluid passes in the opposite direction, the fluid pressure displaces the diaphragm from the seat, and the fluid is allowed to pass from the floating piston cavity at a high rate. Valve 7 compresses spring 8 and opens the hole in slide valve 5 to pass the fluid.

The piston displaces from the sleeve seat and returns into its initial position and the retracting spring sets the slide valve into its place.

After valve 7 is displaced aside, the fluid passes freely through the metering unit to pipe connection B.

II. BOOSTER HYDRAULIC SYSTEM

The booster hydraulic system provides supply of the control boosters. AMT-10 oil is delivered into the system at the operating pressure built up by НШ34-1Т pump 60.

Installed in the pressure line of the system are check valve 5, 8Г11/1С filter 20, ГА-186М safety valve 21, spherical hydraulic accumulator 22, and ..-50/250 pressure gauge pick-up 29.

To feed the БА-45А boosters of the aileron control system, the fluid is delivered through ГА-190Б hydraulic valves 55 and 57.

The stabilizer booster supply system fed from the main and booster systems comprises two check valves 5, two cylindrical hydraulic accumulators 48, ГА-184У valve 47 which disconnects the БУ-51МС stabilizer booster from the booster system, two 11ТФ-4С fine filters 45 and twin check valve 53.

The booster hydraulic system employs emergency pumping unit 54 intended to supply stabilizer booster БУ-51МС in case pumps НШ34-1Т fail or when the engine rotor is jammed.

The ГА-190Б and ГА-184У valves installed in the pressure lines of the booster and main systems near the control boosters are used to disconnect any given booster from the systems. The ГА-184У valve disconnects the stabiliser booster from the booster system while the ГА-190Б valves disconnect the ailerons booster from either the booster or the main system.

In case the pressure in the main and booster hydraulic systems drops (two warning lamps light up), the ГА-190Б valve is cut off by means of depressing the toggle on the right-hand console, so that both aileron boosters are disconnected from the hydraulic system.

When both boosters БУ-45А are disconnected from the two systems, the ailerons are controlled mechanically while the entire pressure reserve is consumed to feed the БУ-51МС booster.

If the systems operate normally, the ГА-190Б valves are invariably cut in to deliver pressure to the БУ-45А boosters.

The button disconnecting the boosters from the booster system is employed only in the case of checking the control system on the ground.

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If the pressure in the booster system drops till it becomes approximately half the amount of the pressure in the main system, the aileron boosters are automatically changed over to delivery from the main system by means of the slide valve switches. When the pressure in the booster system increases till it exceeds half the amount of the pressure in the main system, the aileron boosters are automatically changed over from the main to the booster system.

The two hydraulic systems are equipped with a light warning system: there are two red warning lamps inscribed NO PRESSURE IN BOOSTER SYSTEM and NO PRESSURE IN MAIN SYSTEM. The warning lamps are cut in by two relays ГА-135Т/32, and the relay installed in the booster system cuts in and off the emergency pumping unit.

The emergency pumping unit is switched on in case the pressure in the booster system drops to 165^{+10}_{-5} kg/cm^2.

In this case the signal lamp lights up and the voltage is simultaneously applied to the pumping unit electromotor after which the pumping unit starts to deliver the fluid into the system.

If the control stick is not operated, the pumping unit builds up the pressure in the booster system and is automatically disengaged by the pressure relay at a pressure not above 195 kg/cm^2.

In the course of operation as well as during checking on the ground, it should not be forgotten that when the pressure in the hydraulic system is released by the aileron boosters, the pressure drop warning lamps will light up at a pressure below 165^{+10}_{-5} kg/cm^2 as indicated by the pressure gauge installed in the cockpit.

This is ascribed to the fact that the pressure relays are installed in the fuselage tail section and separated by the check valves from the part of the system mounting the aileron boosters and the pressure gauge pick-up. Therefore, the pressure drops at a lower rate in those parts of the system where the relays are mounted; this leads to a delay in lighting up of the pressure drop warning lamps.

When the pressure inside the system is released by the stabilizer booster, the lamps light up when the pressure is at 165^{+10}_{-5} kg/cm^2.

As the pressure pipe of pumping unit НП-27Т is connected into the section of the booster system pressure line limited by the check valve located near the cylindrical hydraulic accumulator, the pressure built up by the pumping unit is delivered to charge both the spherical and the cylindrical hydraulic accumulators.

The relay breaks the supply circuit of the pumping unit and the warning circuits also when a pressure is built up by pump НП34-1Т.

For the sake of convenience the whole system can be divided into four separate sections:

(a) the system pressure section;
(b) the БУ-45А boosters supply system;
(c) the БУ-51МС boosters supply system;
(d) the emergency system with the НП-27Т pumping unit.

1. <u>Booster System Pressure Section</u> (Fig.164)

The design and operation of the booster system pressure section are analogous to those of the main system.

The difference between them consists in the following:

1. Mounted in the return line at the inlet of the reservoir is gauze filter 58 used instead of the single-flow fine filter.

2. No bleeding valve of the pressure system of reservoir 61 is mounted in the recess housing the connections for coupling to the ground hydraulic installation.

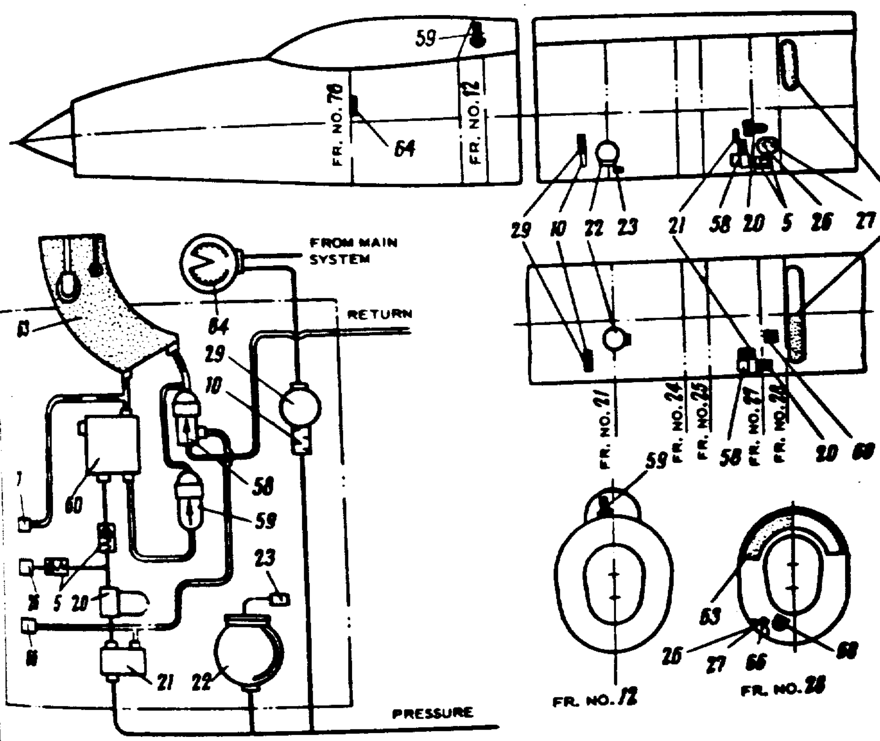

FIG.164. BOOSTER SYSTEM PRESSURE SECTION (Reference numbers are as in Fig.122)
5 - check valve; 10 - throttle; 20 - fine filter; 21 - ГА-186М safety valve; 22 - spherical hydraulic accumulator; 23 - 642500 charging valve; 26 - aircraft connection (pressure); 27 - aircraft connection (suction); 29 - УЗ-90/250 pressure gauge pick-up; 58 - booster system return line gauze filter; 59 - booster pump circulating line filter 11ГФ4С; 60 - booster system pump НП34-1Т; 63 - hydraulic reservoir booster compartment; 64 - УК2-250А pressure gauge indicator; 66 - filling valve.

To charge the booster system, the closed filling is employed. The fluid fed into the reservoir compartment by the charging arrangement passes through charging valve 66 which is installed in the left-hand recess housing the inboard connections.

The pressure section of the system consists of the booster compartment of hydraulic reservoir 63, НП34-1Т pump 60, check valve 5 installed at the pump outlet, ФГ-11/1С filter 59, ГА-186М safety valve 21, hydraulic accumulator 22 with charging valve 23 and valves 26 and 27 for coupling to the ground pump. Connected into the pressure line circuit is ЭДП-50/250 pressure gauge pick-up 29 with damper 10 installed at the inlet.

Gauze filter 58 is installed in the return line at the input of the reservoir.

НП34-1Т pump builds up the pressure inside the system and supplies the fluid to the БУ-45А boosters through the ГА-190Б valve and to the БА-51МС booster through the ГА-184У valve.

The operation of the booster system pressure section is similar to the operation of the main system.

2. Units of Booster System Pressure Section

Gauze Filter (Fig.165)

The gauze filter is installed in the booster system return line at the inlet of the reservoir. The purpose of the filter is to purify the fluid returned from the boosters. It consists of body 1, cover 5, filter frame 3 and gauze filter 2 proper.

The fluid is delivered to the pipe connection in the direction towards the body cover.

3. Aileron Boosters Supply from Booster and Main Systems (Fig.166)

In case the booster and main systems operate normally, the БУ-45А aileron booster is supplied from the booster system only. When the pressure inside the booster system drops down to 85 ±10 kg/cm^2, a special switch installed in the booster automatically changes the boosters over to supply from the main system; and at an increase of pressure in the booster system up to 100 ±5 kg/cm^2 the aileron booster is automatically changed over to supply from the booster system.

The boosters can be disconnected from the booster and main systems by means of the ГА-190Б valves.

When the two boosters are disconnected from the both systems the ailerons are controlled mechanically while the reserved energy is completely consumed to feed the booster stabilizer.

The aileron boosters supply system comprises two ГА-190Б valves 55 and 57 and two ГА-135/21 relays interlocking the pressure system of the КАП-2 autopilot.

4. Aileron Boosters Supply Units

БУ-45А Aileron Booster (Fig.167)

The БУ-45А booster is a hydromechanical unit in which small input efforts transmitted from the control system are transformed into powerful output efforts due to energy expenditure of the fluid pressure.

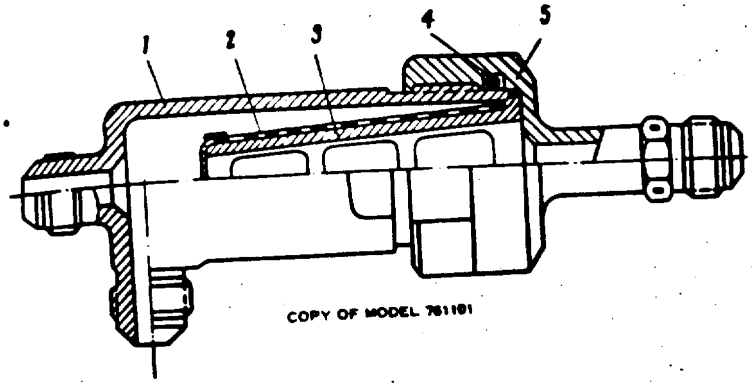

FIG.165. GAUZE FILTER

1 – body; 2 – filter; 3 – filter frame; 4 – packing ring; 5 – cover.

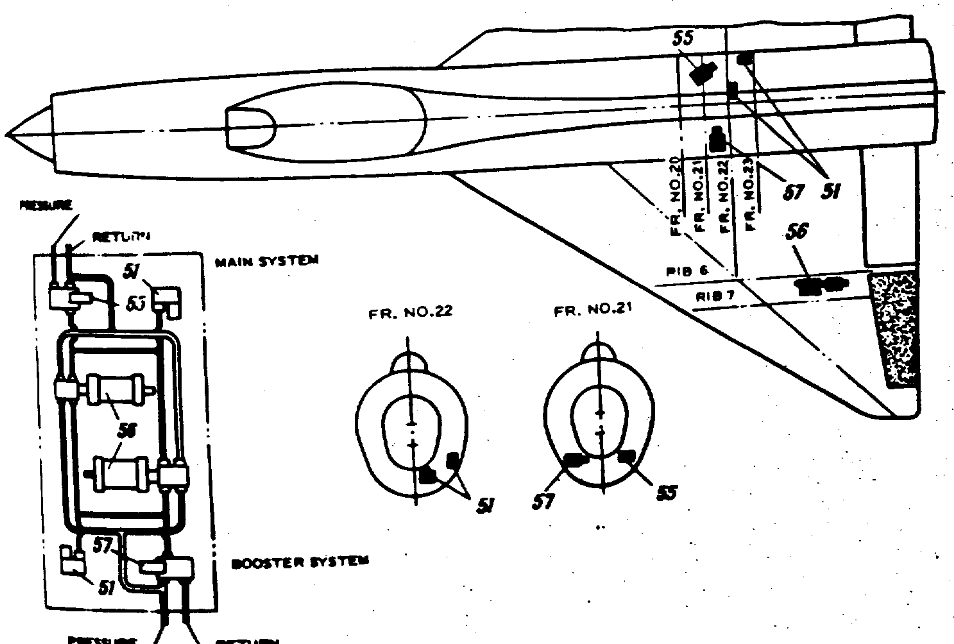

FIG.166. DIAGRAM OF AILERON BOOSTERS SUPPLY FROM BOOSTER AND MAIN SYSTEMS (Reference numbers are as in Fig.122)

51 – pressure-sensitive relay ГА-135/21 for pressure interlocking of autopilot КАП-2; 55 – ГА-196Б valve for disconnecting БУ-45А booster from booster system; 56 – БУ-45А aileron booster; 57 – ГА-196Б valve for disconnecting БУ-45А booster from booster system.

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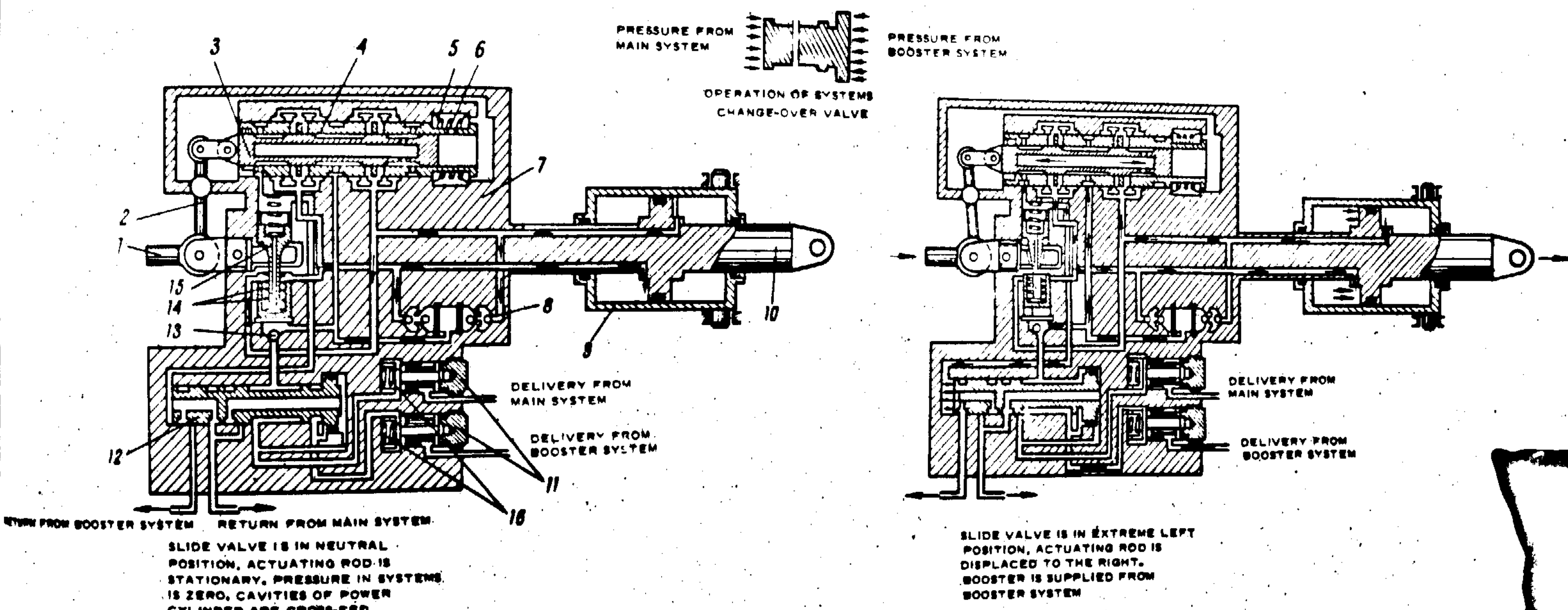

FIG.167. БУ-45А BOOSTER

1 – eyebolt; 2 – lever; 3 – distributing slide valve; 4 – duplicating slide valve; 5 – bushing; 6 – spring; 7 – booster head; 8 – ball valves; 9 – cylinder; 10 – cylinder rod; 11 – inlet filters; 12 – distributing slide valve; 13 – non-return valve; 14 – cross-feed valve; 15 – mechanical retainer; 16 – cut-off valve.

Specifications

1. Maximum effort created by booster at 210 kg/cm^2 .. not less than 1900 kg
2. Actuating rod working travel .... 80 mm
3. Travel of distributing slide valve .... 2 mm
4. Booster non-response zone .... 0.2 mm
5. Speed of actuating rod .... 100 mm/sec.

The БУ-45А booster consists of distributing and actuating assemblies.

The distributing assembly mounted in head 7 comprises slide valve 3, which is connected with the control stick by means of control rods, and duplicating slide valve 4 employed in case the main slide valve is jammed.

The duplicating slide valve is shaped as a sleeve which houses the main slide valve.

When the main slide valve operates normally, the duplicating slide valve is movable.

With jamming of the main slide valve in any position, the duplicating slide valve is caused to displace together with the control stick, the distribution of fluid being effected similarly to that of the main slide valve. This time the effort to be applied to the control stick increases due to compression of spring 6. When the main slide valve operates normally, the duplicating slide valve is fixed by spring mentioned above which sets the duplicating slide valve into the neutral position by means of two bushings 5.

There are four collars in the main and in the duplicating slide valves. The compressed fluid is delivered into the groove located between the two inner collars.

When the slide is in the neutral position, the inner collars cut off the inlet and outlet ducts, through which the fluid is supplied to the working cylinder, and trap the fluid inside the cylinder cavities.

If the distributing slide valve is displaced from the neutral position, the inlet and outlet ducts are opened so as to allow the compressed fluid to pass into one of the cylinder cavities while the compressed fluid contained in the other cavity is forced by the piston into the return line.

Thus, small efforts applied to the aircraft control stick and imparted to the booster slide valve through the control system are converted into considerable efforts on the power cylinder actuating rod.

The БУ-45А booster is provided with a follow-up system which implies that the magnitude, velocity and the direction of displacement of the power cylinder actuating rod vary in proportion with the respective parameters of the distributing slide valve. When the distributing slide valve is stopped, the actuating rod is caused to stop as well.

The booster distributing head is rigidly attached to actuating rod 10 of the power cylinder; as a result, the displacement of the actuating rod causes the distributing head also to displace.

The motion of the control stick is transmitted to the slide valve by means of the rod connected to lever 2 of the distributing slide valve. The lever turns relative to the spherical support due to which the direction of motion of the distributing slide valve is opposite to that of the rod. Due to the arrangement of the inlet ducts of the cylinder, the displacement of the distributing slide valve corresponds to an opposite displacement of the actuating rod, i.e. in the direction same as that of the control rod.

When the control rod stops, the actuating rod continues to move and to displace the distributing head. But inasmuch as the rod is immovable, the rod turns relatively to another point of rotation, and, consequently, the slide valve reverses the direction of motion so that its collars cut off the ducts through which the fluid passes to the power cylinder. Finally, the slide valve is set into its neutral position and the actuating rod stops.

Thus, while the actuating rod executes a follow-up motion, it exactly repeats the motion of the control system rod connected to the booster.

Since the displacement of the slide valve is as small as tenths of a millimetre, the time interval between the instant of stop of the control rod and the instant of stop of the actuating rod is immaterial. Similarly, the value of the additional movement of the actuating rod executed after the control rod ceases its displacement is negligible though it is quite sufficient to shift the slide valve into the neutral position.

Owing to the flats made on the working collars of the slide valve, the actuating rod is caused to displace smoothly and gradually increase its speed depending on the travel of the slide valve.

In the neutral position the sleeve grooves of the distributing slide valve are closed by the slide valve collars so that the so-called booster non-response zone is formed.

Incorporated in the distributing head of the БУ-45А booster is the system change-over valve which is essentially floating slide valve 12 caused to displace due to a pressure differential in the systems.

The change-over valve of the БУ-45А system operates as follows:

1. At normal pressure in the both systems the booster is cut into the booster system.

2. When the pressure in the booster system drops to 85 $\pm$10 kg/cm^2, the booster is changed over to the main system.

3. When the pressure in the booster system increases to 100 $\pm$5 kg/cm^2, the booster is changed over to the booster system.

In case both the hydraulic systems fail or if the boosters are disconnected from the systems, the manual mechanical control system is engaged automatically.

In this case the distributing slide valve is locked in the neutral position by mechanical retainer 15 and the cavities of the power cylinder become interconnected and communicate with the return line through cross-feed valve 14.

If there is a working pressure in the hydraulic system, the plunger of cross-feed valve 14 cuts off the ducts and disconnects the cavities of the cylinder by means of its collars. When the pressure drops, the cross-feed valve plunger is displaced due to the action of the spring and the ducts interconnecting the cylinder cavities are opened.

In this case the booster operates as a linkage in the control system. To prevent excessive aerodynamic stresses on the control stick caused due to an instantaneous pressure drop, the booster is fitted with ball valves 8.

When the pressure in the system drops, valves 8 deliver fluid to the cross-feed valve from one of the power cylinder cavities in which at this moment the fluid is in the state of compression due to aerodynamic forces acting on the booster rod.

Only after the pressure drops down to 5 kg/cm^2, the cross-feed valve interconnects the cylinder cavities and effects a smooth change-over to the manual control.

Non-return valve 13 is designed to prevent the backward movement of the booster rod acted upon by the aerodynamic stresses; together with other valves, provides an additional supply of fluid due to which the fluid is not allowed to pass from the pressure cavity to the booster distributing slide valve.

Installed after the pipe connections which deliver the pressure from the main and booster systems are inlet gauze filters 11.

Built into the booster are spring-loaded plungers 16 which shut off the passages of fluid after the filters are removed so as to prevent the drainage of fluid and penetration of foreign matter into the booster inner cavities.

The booster cylinder has two trunnions to attach it rigidly in the bracket mounted on the bearings. Connected to the actuating rod is the control system bell-crank while eyebolt 1 secured to the control slide valve lever is attached to the control rod actuated by the control stick.

The boosters are installed on rib 6, one in each wing.

ГА-190Б Valve (Fig.168)

The ГА-190Б valve is a two-position valve installed in the БУ-45А boosters supply system. It is used to supply the compressed fluid to the booster or to interconnect the booster pressure line to the return line during a change-over operation.

The valve consists of body 1, ball valve 4 governed by electromagnet 6 and distributing slide valve 3. The distributing slide valve is driven by pistons 5 and 2, piston 2 being provided with a retracting spring.

Housed inside the electromagnet are two coils. The right-hand section of the electromagnet contains switch bell-crank 7 and folding lever 8 with a spring. The folding lever is connected to the magnet core by means of a link and a stay.

The folding lever is used to lock the ball valve in the extreme positions and to shift the switch bell-crank from one position into another.

When the left coil is energized, the core displaces to the left and drives the ball valve connected to it. The ball valve cuts off the pressure line from the cavity of the right control piston and connects the cavity to the return line.

As the compressed spring acts upon the left control piston, the actuating part of the piston causes the slide valve and, hence, the right control piston to displace so that the pressure line is connected to the outlet connection and the fluid is delivered to the booster.

The instant when the core comes against the stop, the switch bell-crank cuts off the voltage fed to the left coil and the valve controller is fixed by the folding lever and its spring. The contacts of the bell-crank are shifted over to the electric circuit of the right-hand coil to make it ready to change over the valve.

When the right-hand coil is energized, the compressed fluid is delivered through the ball valve under the right-hand control piston which leads to a change-over of the slide valve. The pressure line is cut-off and the booster supply line is connected to the return line. The ГА-190 valves are installed in the lower part of frames Nos 20-22.

ГА-135/21 Pressure-Sensitive Relay (Fig.173)

The ГА-135/21 pressure-sensitive relays are installed in the main and booster systems at the outlets of the ГА-190Б valves in the aileron booster pressure supply lines. The relays are intended for interlocking the pressure system of the КАП-2 autopilot.

The pressure-sensitive relay used in the КАП-2 system is intended to cut off the РАУ-107 servo unit from the electric supply circuit when the pressure inside the hydraulic system drops or when the aileron boosters are disconnected. Hence, the

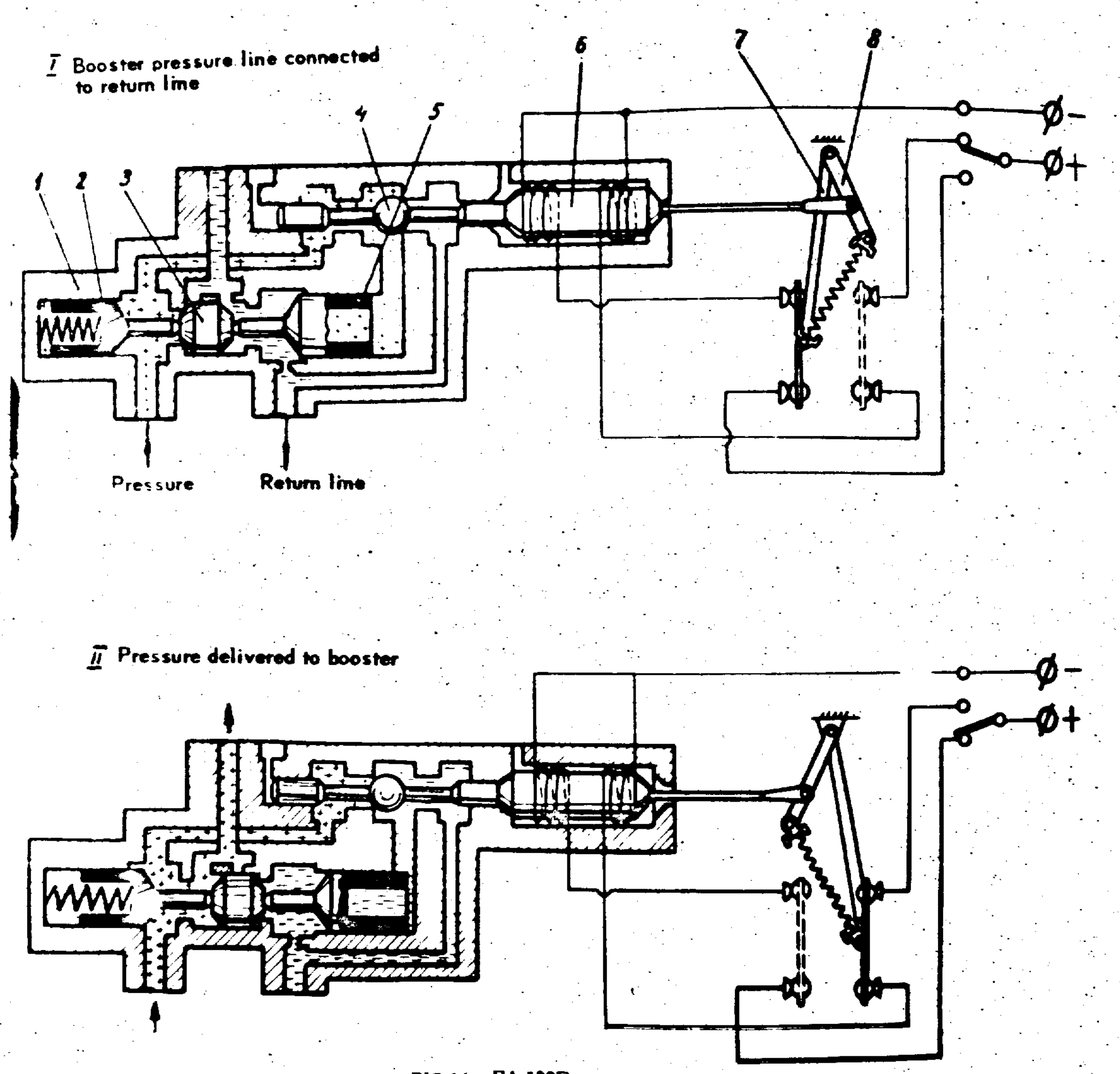

FIG.168. ГА-100Б VALVE

1 – body; 2 – piston; 3 – distributing slide valve; 4 – ball valve; 5 – piston; 6 – electromagnet; 7 – bell crank; 8 – folding lever.

relay prevents the damage of the PAУ-107 servo unit in case the pressure inside the hydraulic systems is zero.

The relay operates within the pressure ranges listed below:

1. Pressure of working fluid at which the electric circuit is closed and the PAУ-107 servo unit is engaged .... not above 90 kg/cm^2
2. Pressure of working fluid at which the electric circuit is broken and the PAУ-107 servo unit is cut-off .... not less than 70 kg/cm^2

The design of the ГA-135/21 relay is similar to ГA-135T/32 described in section "Stabilizer Booster Supply from Booster and Main Systems."

5. Stabilizer Booster Supply from Booster and Main Systems

(Fig.169)

When the booster and main systems operate normally, the stabilizer booster is fed from both systems simultaneously.

During ground checking the booster can be disconnected from the booster system by means of the ГA-184У valve.

In order to ensure the steering of the aircraft when the engine rotor is jammed or if both pumps fail, the booster system is fitted with an emergency system comprising the НП-27Т emergency pumping unit driven by the electromotor which is fed from the aircraft mains. The emergency pumping unit is installed in the system so that the pressure built up by the unit is used to charge both the cylindrical and spherical hydraulic accumulators.

The БУ-51МС stabilizer control system comprises two hydraulic accumulators 48, two filters 45, ГA-184У valve 47 used to disconnect the booster from the booster system, two air pressure gauges 52, check valve 5, twin check valve 53 and two ГA-135T/32 relays 49 warning about a drop of pressure in the booster and main systems.

The emergency system comprises НП-27Т pumping unit 54 and check valve 5 installed at the inlet of the pumping unit. Together with one of the valves of the twin check valve, the check valve mentioned above prevents the fluid compressed by the НП-34-1Т pump from penetrating into the emergency unit since otherwise the unit may overspeed and start operating as a motor.

6. Stabilizer Booster Supply Units

БУ-51МС Stabilizer Booster (Fig.170)

The БУ-51МС stabilizer booster differs from the БУ-45А aileron boosters by the availability of two cylinder cavities which are fed with fluid from different systems and employ their own distributing devices.

The stabilizer booster is designed to operate simultaneously with two hydraulic systems.

These hydraulic systems function independently and are separated from each other.

If one of the systems fails, the booster can operate from the other system.

The booster has a non-return valve installed at the inlet of each hydraulic systems.

The stabilizer cannot be manually controlled through the booster.

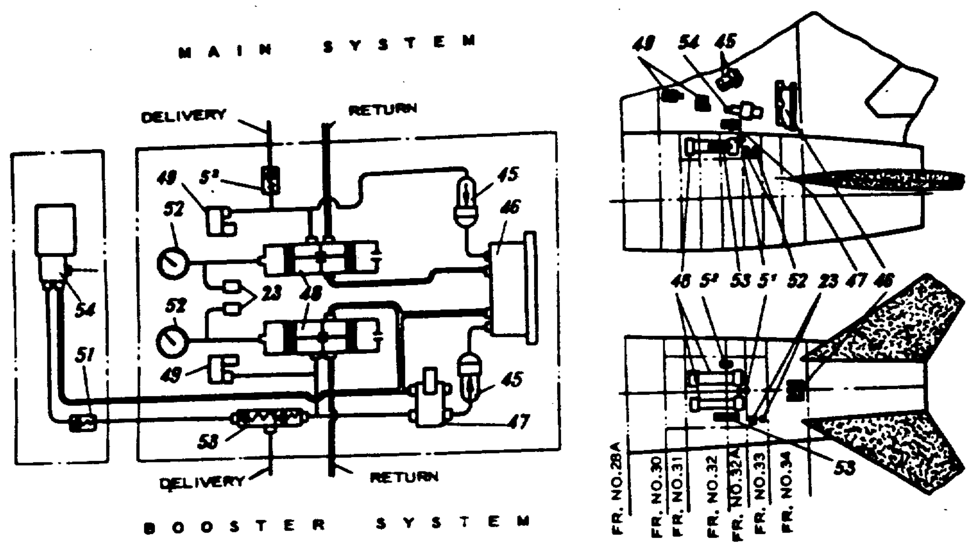

FIG.169. DIAGRAM OF STABILIZER BOOSTER SUPPLY FROM BOOSTER AND MAIN SYSTEMS (Reference numbers are as in Fig.122)

5 – check valve; 23 – filling valve 642500; 45 – 11ГФ4С fine filter; 46 – БУ-51МС stabilizer booster; 47 – ГА-184У valve for disconnecting БУ-51МС booster from booster system; 48 – cylindrical hydraulic accumulator; 49 – ГА-135/32 pressure-sensitive relay; 52 – cylindrical hydraulic accumulator air pressure gauge МВ-250М; 53 – dual check valve; 54 – НП-27Т emergency pumping unit.

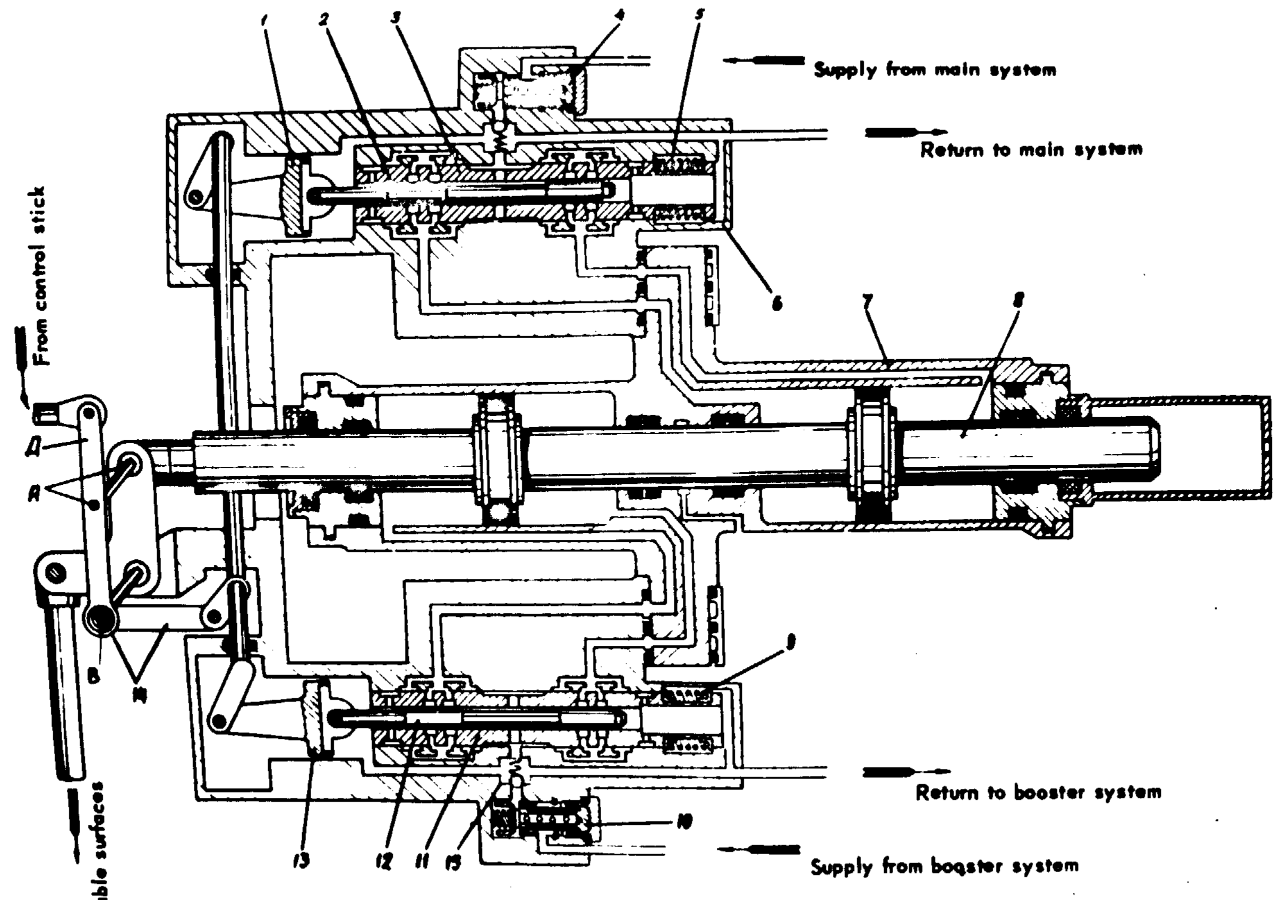

FIG.170. БУ-51МС BOOSTER

1 – damper; 2 – main distributing slide valve; 3 – duplicating slide valve; 4 – inlet filter; 5 – duplicating slide valve spring; 6 – bracket; 7 – cylinder; 8 – actuating cylinder rod; 9 – duplicating slide valve spring; 10 – inlet filter; 11 – duplicating slide valve; 12 – main slide valve; 13 – damper; 14 – system of connecting rods, bell-cranks and levers; 15 – non-return valve.

Specifications

1. Maximum effort exerted by the booster upon the actuating rod when the pressure in both systems is 210 kg/cm^2 ...... 5800 kg
2. Maximum effort exerted by the booster upon the outlet bell-crank set in the neutral position when the pressure in both cavities is 210 kg/cm^2 and the speed is zero .... 3800 kg
3. Working travel of the actuating rod .... 70 mm
4. Speed of the actuating rod without loads upon the rod when the main slide valves are engaged .... 49 to 61 mm/sec.

From the point of view of the principle employed, the booster is a hydro-mechanical unit with a follow-up system.

The booster uses one actuating and two distributing assemblies.

The actuating assembly is a twin cylinder provided with two pistons driven by a common piston rod.

The distributing assembly consists of main slide valve 12 and 2, duplicating distributing slide valve 3 and 11, and linkage mechanism 14 which actuates the slide valves.

The distributing assemblies are located in bracket 6 which carries power cylinder 7. The cylinder can perform only rocking motions. The synchronous operation of the booster, i.e. dependence of the speed and travel of the actuating rod upon the respective parameters of the distributing slide valve, is ensured by the use of a leverage and rocker arm system which establish a mechanical feedback.

The booster is controlled by means of displacing the distributing slide valves through lever Д connected to the control stick.

When lever Д is displaced, it turns about point A since the actuating rod is immovable at this instant.

As soon as the main distributing slide valve opens the slots of the duplicating slide valve, the working fluid enters the cylinder and sets actuating rod 8 in motion directed similarly as that of control rod.

The actuating rod moves as long as the main slide valve is displaced relative to the duplicating slide valve inner grooves, i.e. lever Д moves together with the control stick and the actuating rod.

When the control stick and, hence, lever Д stop, the actuating rod continues to move.

The axis of rotation is translated into fixed point B, so that lever Д acted upon by the actuating rod starts to displace together with the distributing slide valve away from the sleeve. The lever moves on until the by-pass slots of the distributing assembly slots are shut off which causes the actuating rod to stop.

Since the passage area of the by-pass slots is small and the slide valve collars overlap the sleeve grooves by 0.2 mm (non-response zone), the follow-up movement proceeding after the control stick has stopped, is performed within a very short interval of time and covers a small length which does not affect the aircraft controllability.

Similar processes occur in the booster while lever Д moves in the opposite direction.

This is the way the follow-up control of the booster is effected.

The distributing assembly consists of the main and duplicating slide valves and of a system of ducts through which the working fluid is fed from the distributing assembly to and from the cylinder cavity.

The fluid is first delivered to inlet filter 4 and 10 and then to the distributing assemblies.

The main distributing slide valves are mounted inside the duplicating valves and have two collars each. The collars are located opposite the grooves in the duplicating slide valves connected to the respective cylinder cavities through the ducts in the sleeve and in the bracket.

The duplicating distributing valves are also provided with collars located opposite the grooves in the sleeves. Both sides of the collars of the main and duplicating slide valves are fitted with flats to achieve a smooth increase in the speed of the actuating rod moving similarly as the distributing slide valve.

When the distributing slide valves are in the neutral position, the collars of the main and duplicating slide valves close the ducts connected to the cylinder cavities.

When the duplicating slide valves are engaged, the effort applied to the control stick increases since apart from the friction, the tension of springs 5 and 9 must be overcome to shift the duplicating slide valve.

To eliminate the effects of vibration of the control system upon the booster slide valves, the control levers are coupled to the slide valves by means of damper 1 and 13.

The damper is designed as a piston inserted into the sleeve with a definite clearance. When the piston moves, the fluid displaced through the clearance cushions the motion.

CAUTION! It is strictly forbidden to deliver a pressure to the booster from any system when the return pipe connections are plugged.
In the course of operation of the hydraulic booster the permissible leakage of fluid forced out through the outer packings is within 2 cm^3/hr.

НП-27Т Emergency Pumping Unit (Fig.171)

The emergency pumping unit comprises a constant delivery hydraulic piston pump and an electric motor, type Д880, with a reduction gear. The pumping unit supplies the compressed fluid into the system whatever a pressure drop may be.

Specifications

1. Maximum delivery pressure .... 210 kg/cm^2
2. Consumed current intensity when a pressure of 185 kg/cm^2 is built up by the unit at +20°C .. not above 55 A
3. Intake pipe connection pressure .... within 2 to 3 atm. abs.
4. Pumping unit capacity when the voltage is 27 V, the inlet pressure is 2 atm.abs. and the pressure of outlet fluid is 210 kg/cm^2:
   - at the initial stage of service .... not less than 1.9 lit/min.
   - at the end of the service life .... not less than 1.6 lit/min.

The pumping unit comprises an electric motor and a pump.

The pump consists of housing 7, sleeve 8, shaft 1 with rods 5 rolled into the seats, pistons 4 attached at the ends of the piston rods, universal joint 6, piston assembly 2 and cover 3. The delivery and suction lines run from the pump butt end.

The design and principle of operation of the pump is similar to those of the НП34-1Т pump. However piston assembly of this pump is stationary to make pump delivery unadjustable.

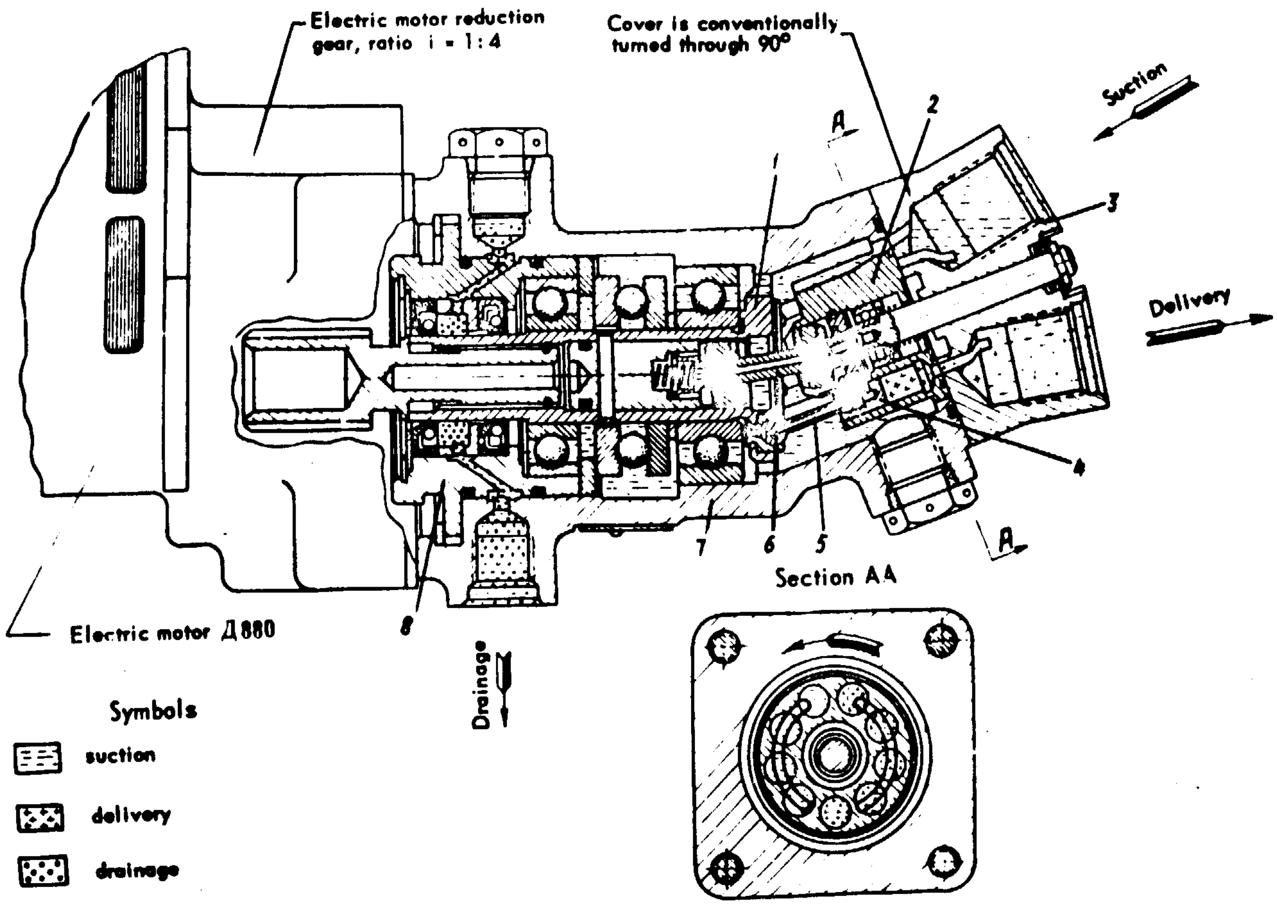

FIG 171. [illegible]-2"T EMERGENCY PUMPING UNIT
1 — pump shaft; 2 — rotor; 3 — cover; 4 — piston; 6 — universal joint; 7 — housing; 8 — sleeve

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In the course of operation of the pumping unit care should be taken that the pumping unit is properly secured to the bracket so as to prevent loosening of the bolts and that the tightness of pipe connections and contact in joints of the current-carrying wires are reliable.

The pumping unit is installed on the fin-carrying stiffening member.

Cylindrical Hydraulic Accumulator (Fig.172)

Each system is fitted with a cylindrical hydraulic accumulator to increase the reliability of operation of the stabilizer control system. Installed in the pressure lines at the inlets of the cylindrical hydraulic accumulators are the check valves through which the hydraulic accumulators can discharge into the БУ-51МС booster only.

The hydraulic accumulator consists of sleeve 3 divided by partition 5 into high-pressure and low-pressure chambers, covers 2 and 8, piston assembly 4 and 7 and ring 1 and 6.

The hydraulic accumulator has high-pressure, gas-charging and return pressure chambers. Each of the chambers has pipe connections, two of them coupling to the return chamber.

The gas chamber is charged via a charging pipe connection located separately from the hydraulic accumulator. The gas chamber is filled with nitrogen at 50^{+5} kg/cm^2 while the piston is set into its extreme right-hand position. In this case the volume of the hydraulic high-pressure chamber is a minimum whereas the volume of the return chamber is a maximum. When the pressure of fluid in the system is higher than the charging pressure, the piston is set in motion and the gas is compressed.

When the volume of the high-pressure chamber increases the return chamber piston which is rod-connected to the high-pressure chamber piston forces the fluid out into the return line.

Therefore, the fluid filled into the reservoir is not consumed to charge the cylindrical hydraulic accumulators.

The fluid returned from the БУ-51МС booster is supplied through one of the return pipe connections, while the other pipe connection is coupled to the return line. The side of the accumulator where the return chamber is situated, is closed with a cover communicated with the atmosphere through a filter to prevent compression caused due to motion of the pistons. While the hydraulic accumulator is discharged, the volume of the high-pressure chamber being reduced, the low-pressure chamber gets filled.

CAUTION: 1. After charging the hydraulic accumulators with compressed nitrogen at 50^{+5} kg/cm^2, sh... the stick in the cockpit several times in longitudinal direction and make sure that the reference pressure gauge does not indicate a pressure drop and that the stabilizer does not displace.

2. Never deliver compressed fluid through the charging pipe connection if the return pipe connections are plugged or the return line is shut off, and never operate the stabiliser from any system while the pipelines in the other system are plugged.

The charging pressure is checked with the help of pressure gauges inserted into the hydraulic accumulator charging line. The accumulator charging pipe connection and the pressure gauge are installed in the hydraulic accumulator compartment.

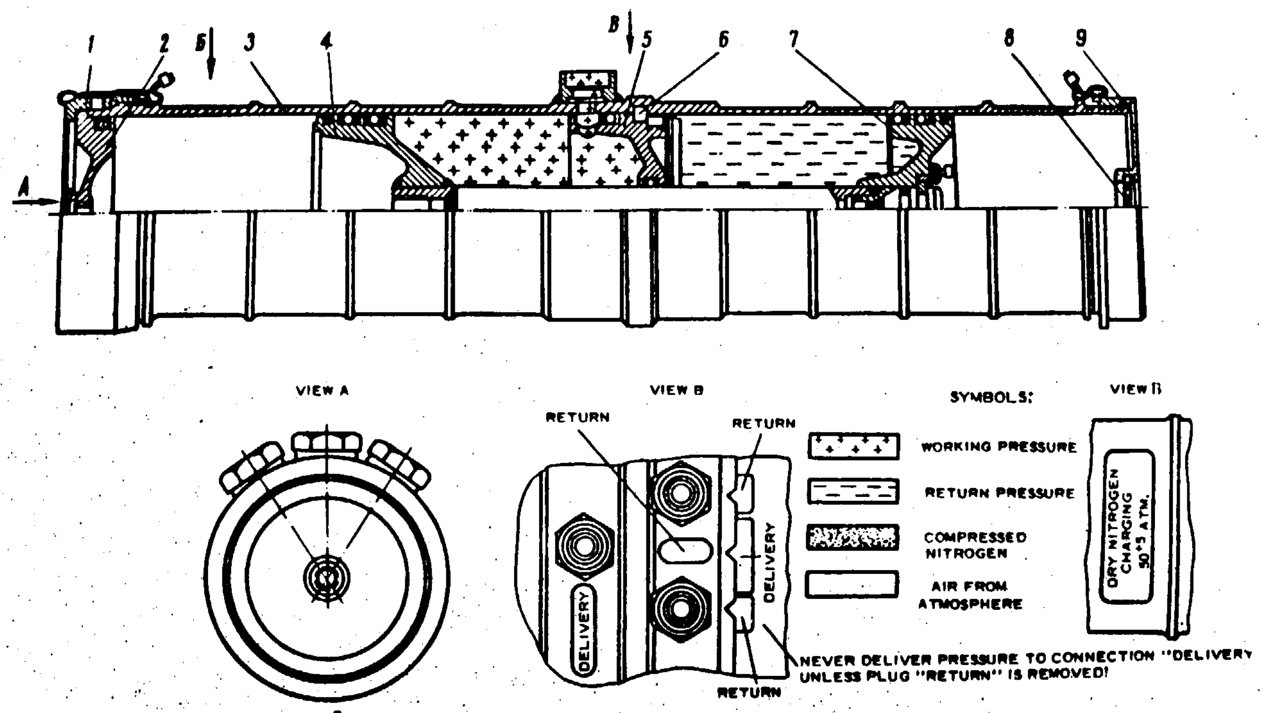


FIG.172. CYLINDRICAL HYDRAULIC ACCUMULATOR
1 – ring; 2 – cover; 3 – sleeve; 4 – piston; 5 – partition; 6 – ring; 7 – piston; 8 – filter 9 – cover.

ГА-184У Valve

The ГА-184У valve is used to disconnect the stabiliser booster from the booster system. The valve is employed only in cases of checking the stabiliser control system on the ground. The description of the valve is given in Section "Cone Control Units".

11Г04 Filter

The 11Г04 filter is installed in the pressure line of the booster and main systems at the inlet of the БУ-51МС booster. The description of the filter is given under "Pressure Section of Main System."

ГА-135Т/32 Pressure-Sensitive Relay (Fig.173)

The pressure-sensitive relay is designed for automatic breaking and closing the warning circuit as well as for switching the emergency pumping unit depending on the fluid pressure in the hydraulic system.

The relay consists of body 3, seat 1, tappet 5 with piston, nut 2 and spring 4. Attached to the body holders is a microswitch covered with a cap. The microswitch electric circuit is fed through a plug connector. The relay is adjusted to change over at a definite pressure within the range from P_1 to P_2.

When the pressure fed to the pipe connection is less than operating pressure P_1, the spring displaces the seat away from the switch button. The switch keeps the circuit closed. When the pressure upon the piston increases, the piston overcomes the resistance of the spring, displaces the seat to the left and at a pressure above P_2 depresses the switch button. The switch operates and breaks the circuit.

With further increase in pressure the piston moves to its extreme position, the seat stops and the lamp does not glow as the circuit remains broken.

The given relay cuts in the warning lamp when the pressure in the system is 165^{+10}_{-5} kg/cm^2 and cuts the lamp off when the pressure is not more than 195 kg/cm^2.

Mounted before the relay is damper 6 intended to eliminate the effect of pressure pulsation upon the relay.

Charging Valve 642500 (Fig.174)

The charging valve installed in the spherical and at the cylindrical hydraulic accumulators is designed to charge the accumulator gas chambers with subsequent locking of the chambers after charging.

The valve consists of body 4, cover 1 with a cable and pressure rod 3 with retracting spring 5.

In its turn, the rod consists of tapered rubber washer 7, bush 6 and nut 2. The tapered washer is installed inside a respective groove of the body.

When the accumulators are charged, rod 3 with tapered washer 7 is pressed downwards by a special pressing device so that a passage is made through which the chamber is filled with nitrogen. While the rod travels in the opposite direction, the tapered washer is set into the seat and fixed thereat by the pressure of nitrogen which ensures tightness of the gas chamber.

Dual Check Valve (Fig.175)

The dual check valve consists of two check valves attached in parallel to each other. One of these is intended to provide a one-direction supply of compressed

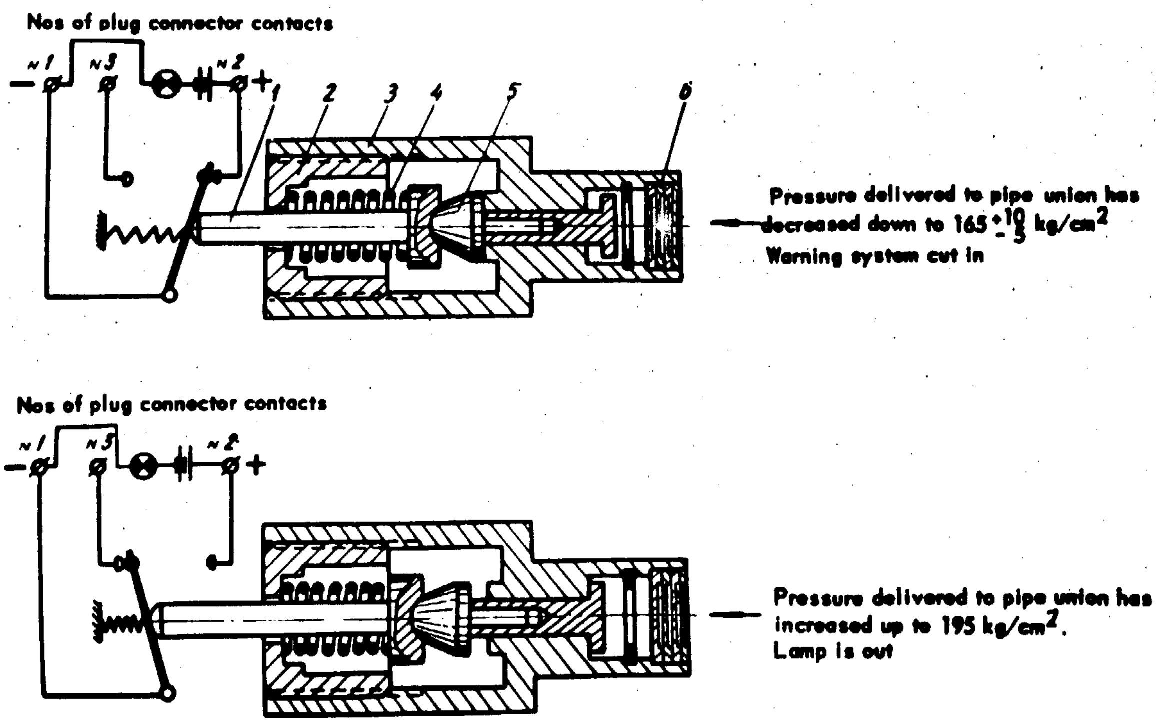


FIG.173. ΓA-135T/32 PRESSURE-SENSITIVE RELAY
1 – seat; 2 – nut; 3 – body; 4 – spring; 5 – tappet; 6 – damper.

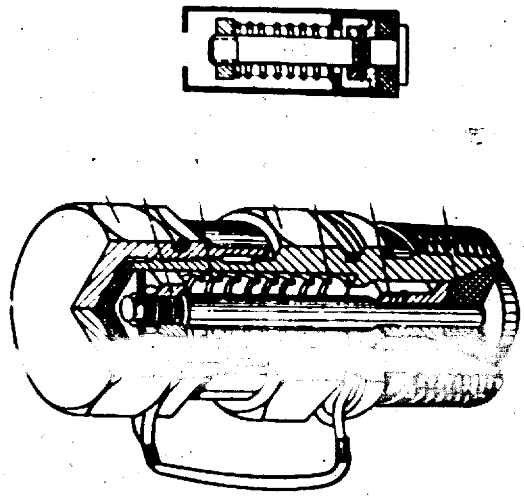


FIG.174. 642500 CHARGING VALVE
1 – cover; 2 – nut; 3 – pressure rod; 4 – body; 5 – spring; ...
7 – tapered rubber washer.

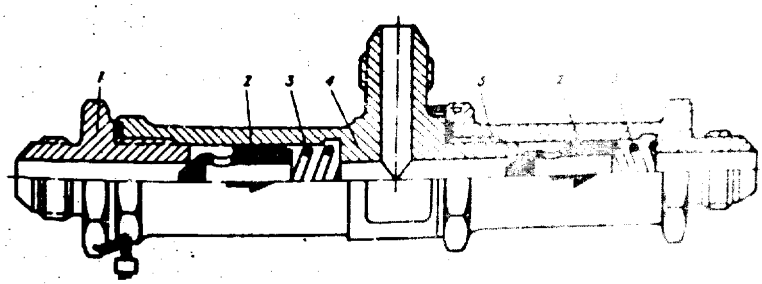


FIG.175. DUAL CHECK VALVE
1 – pipe connection. 2 – valve head, 3 – spring, 4 – body, 5 – pipe connection

fluid stored inside the cylindrical hydraulic accumulator and discharged into the БУ-51МС booster only, while the other is the secondary valve intended to ensure reliable operation of the line coupling the НП-27Т pumping unit to the cylindrical hydraulic accumulator.

The valve consists of body 4 which interconnects pipe connections 1 and 5, and of valve heads 2 and spring 3. Each cavity formed inside the valve houses one valve head and a spring.

The intermediate pipe connection supplies the pressure delivered from the booster pressure line. The principle of operation employed in the check valve is described under "Pressure Section Units of Main System".

МВ-250М Air Pressure Gauge

The МВ-250М air pressure gauge installed in the cylindrical accumulator air charging system is intended to indicate the charging pressure which must be equal to 50^{+5} kg/cm^2.

The principle utilized in the pressure gauge is based on the property of an arc-shaped tube spring to deform when a pressure is supplied inside its internal cavity. As the tube spring is deformed, its free end shifts and actuates a gearing which in turn causes the pressure gauge pointer to travel over the scale to enable measurements of pressure fed to the gauge.

The design of the pressure gauge is similar to that of the МВ-12 pressure gauge described in Volume IV (Part II).

III. HYDRAULIC RESERVOIR PRESSURIZATION SYSTEM (Fig.176)

The hydraulic reservoir is equipped with a working fluid pressurization system intended to improve the operating conditions of the НП34-1Т pumps and to increase the operational ceiling of the hydraulic system.

The pressurization system consists of pipelines delivering compressed air from the sixth stage of the engine compressor to the reservoir. The pressurization line comprises the following elements: pressurization unit 69, 682600A reducer 66, pressurization valve 67, sump 70 and release valve 61.

The air delivered from the compressor at a pressure of 10 to 12 kg/cm^2 is fed into the pressurization unit which is fitted with a check valve and a filter installed at the inlet of the unit. At the outlet of the pressurization unit the air pressure is reduced to 1.7 to 2.6 kg/cm^2 by the 682600A reducer and is delivered into the hydraulic reservoir through the pressurization valve. When the pressure in the reservoir increases to 28 $\pm$0.3 kg/cm^2, the excess air is released through the safety valve of the pressurization valve. The pressurization valve check valves are installed in series in the reservoir pressurization line to prevent the air flowing out of the reservoir in the opposite direction. To remove condensate and prevent freezing of water inside the pressurization unit and pipelines, a sump is installed in the left wheel well before the pressurization unit. The sump has an orifice of 1 mm dia. which provides a continuous blowing-off of the system to remove the moisture from the sump and the system. When checking the hydraulic system on the ground, the hydraulic reservoir is pressurized as follows. The right-hand recess housing the inboard charging connections is provided with a release valve coupled to the line which connects the pressurization valve to the reservoir.

The release valve is intended to exhaust the compressed air from the reservoir during filling and is simultaneously employed as a pipe connection to couple the pressurization system to the ground installation during a ground checking of the

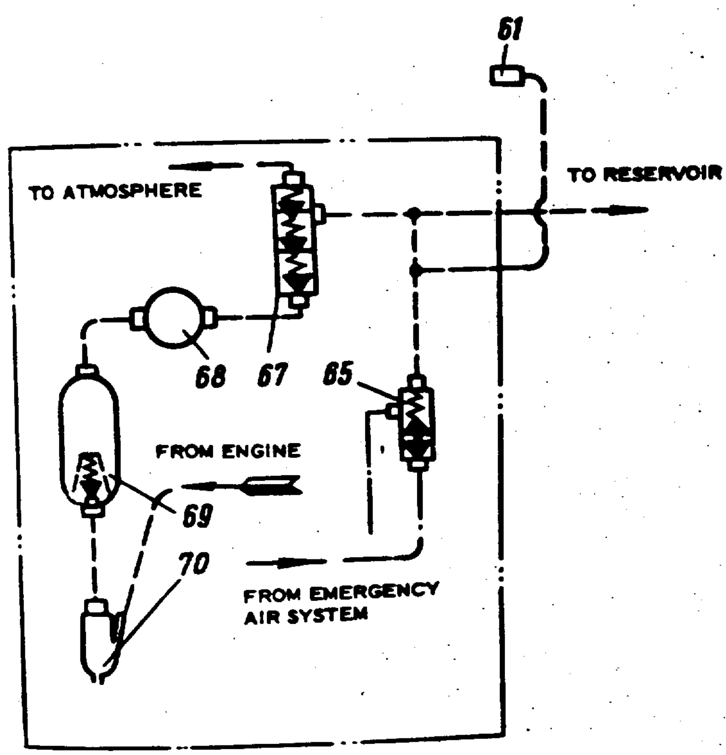


FIG. 176. HYDRAULIC RESERVOIR PRESSURIZATION SYSTEM (Reference numbers are as in Fig.122)
61 – release valve; 65 – vent valve; 67 – pressurization valve; 68 – reducer 682600A; 69 – pressurization unit; 70 – sump.

system. The air supplied from the ground pressurization installation should be delivered at a pressure of 1.7 to 2.6 kg/cm^2.

1. Pressurization System Units

Pressurization Unit (Fig.177)

The pressurization unit is intended to store the compressed air inside the pressurization system. It is essentially an air bottle whose inlet pipe connection 1 is provided with check valve 2, a silk filter and two gauze filters.

The bottle capacity is 1.3 lit. and the working pressure is 12 kg/cm^2. The bottle is manufactured according to the special standards and should be regularly tested at a pressure of 18 kg/cm^2 every 3 years.

The bottle has a welded body; welded up to the bottle bottom are cups which incorporate inlet and outlet pipe connections.

The inlet pipe connection manufactured of stainless steel contains a check valve with a spring and filters.

Attached to the unit housing is a plate containing the technical data and the assigned date of the next check.

The unit is installed in the left wheel well and attached thereat by means of two soft clamps.

Pressurization Valve (Fig.178)

The pressurization valve prevents the flow of air from the hydraulic reservoir to the pressurization line when the pressure in the line drops, and also does not allow the fluid to get into the pressurization line. Besides, when the pressure in the reservoir increases due to fluctuations of fluid levels or because of unserviceability of the pressurization system reducer, the excess pressure is released into the atmosphere through the valve safety device.

The pressurization valve consists of two check valves 3 and safety valve 7. There are three pipe connections on the valve body which are coupled as follows: connection A is coupled to the aircraft pressurization line, connection Б is coupled to the hydraulic reservoir and release valve, and connection B is coupled to the drain pipe used to release the excess pressure of the air in the reservoir into the atmosphere.

When the engine is operated, the air delivered from the compressor into the reservoir passes through two pressurization check valves which prevent the flow of the air from the reservoir into the system when the pressure in the system drops. Meanwhile, the release valve cuts off the passage of the air from the reservoir to the atmosphere through the ground pressurization line.

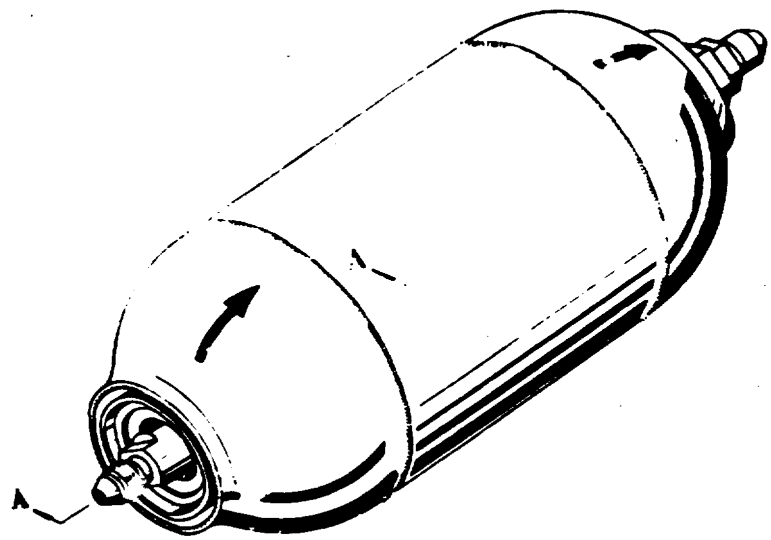
When the pressure of the air contained in the reservoir increases, safety valve 7 is displaced from its seat, so that spring 8 is compressed and the excess pressure is released into the atmosphere.

The valve starts to open when the pressure increases up to 2.8 $\pm$0.3 kg/cm^2.

The pressurization valve is installed in the engine compartment on the left side between frames Nos 27 and 28.

Release Valve

The release valve serves as a pipe connection for coupling to the ground pressurization system, on the one hand, and is employed to release the compressed air from the hydraulic reservoir, on the other.



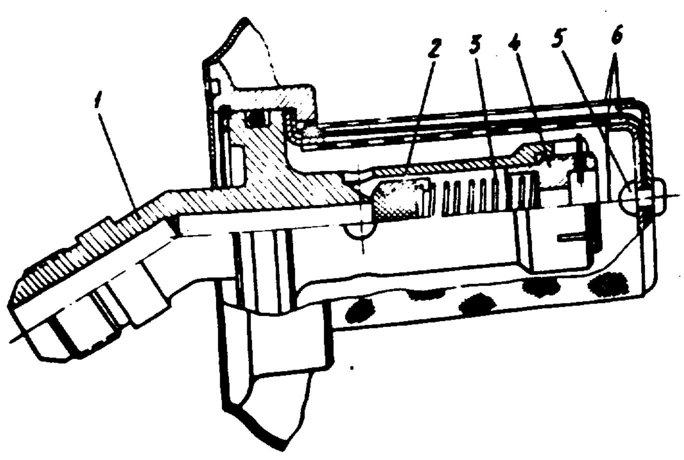


FIG.177. PRESSURIZATION UNIT
1 – inlet pipe connection; 2 – check valve; 3 – spring; 4 – support; 5 – rivet; 6 – silk and gauze filters.

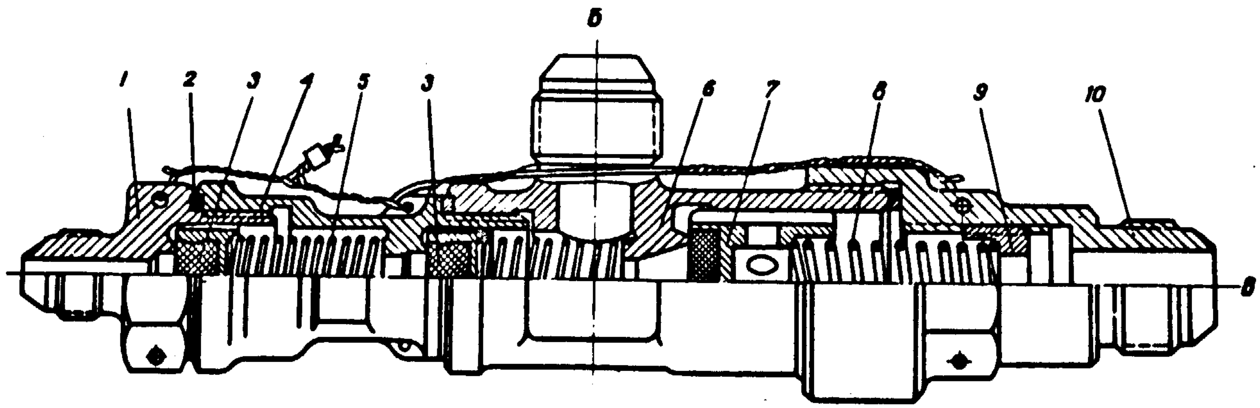


FIG.178. PRESSURIZATION VALVE
1 – pipe connection; 2 – packing washer; 3 – check valve; 4 – body; 5 – spring; 6 – body; 7 – safety valve; 8 – spring; 9 – nut; 10 – cover.

It is essentially a pipe connection with an air valve moving inside it. The air valve is pressed to a seat in the body by means of a spring. The connection is closed with a plug which has a port in the centre to pass a rod with a button. When the button is depressed, the rod drives the valve from the seat, due to which the hydraulic reservoir is connected with the atmosphere and the air is released from the reservoir.

To couple to the ground pressurization system, the plug must first be unscrewed (as well as the rod and the button attached to it) and the hose of the ground installation is to be coupled to the pipe connection from which the plug has been removed.

Sump

The sump is a hollow cylinder fitted with two pipe connections welded to it. The connection installed at the cylinder side is coupled to the pipe delivering the air from the compressor, while the connection installed in the upper part of the cylinder is coupled to the pipe communicating with the pressurization unit. The lower part of the cylinder has a hole to ensure a continuous air blow to remove the condensate.

Chapter VI

AIRCRAFT CONTROL SYSTEM

I. GENERAL

The aircraft control system (Fig.179) consists of:

(a) the stabilizer control system;

(b) the rudder control system;

(c) the aileron control system.

1. Stabilizer Control System

The stabilizer is controlled by the control stick installed in the cockpit and linked to the stabilizer by means of tubular control rods, intermediate levers and bell-cranks.

The stabilizer control system is equipped with the spring artificial feel mechanism, the trimming effect mechanism, the БУ-51МС hydraulic booster and automatic transmission ratio controller АРУ-3В.

The spring artificial feel mechanism installed in the stabilizer control system is intended to immitate the efforts applied to the control stick. The trimming effect mechanism, type МП-100М, is employed as an aerodynamic trimmer to transmit the efforts on the control stick in the required direction.

The БУ-51МС hydraulic booster is used to transmit the movements to both halves of the stabilizer simultaneously. It is connected to the stabilizer control system in a non-reversible manner and responds to all hinge moments produced by aerodynamic forces acting on the stabilizer.

To mount or inspect the boosters, the detachable superstructure in the tail fin should be removed.

In order to reduce the stabilizer effect at high speeds and low altitudes, the stabilizer control system is fitted with an automatic transmission ratio controller, type АРУ-3В. The controller changes the stick-to-stabilizer transmission ratio and simultaneously stick-to-spring artificial feel mechanism transmission ratio.

The stabilizer nose is deflected through $28^\circ \pm 1^\circ$ downwards and $13^\circ \pm 1$ upwards relative to the neutral line when the rod of the АРУ-3В controller is fully extended and through $15^\circ \pm 1^\circ$ downwards and $4^\circ \pm 1^\circ$ upwards when the controller rod is fully retracted.

2. Aileron Control System

The ailerons are controlled by the control stick. The system comprises the spring artificial feel mechanism, transmission ratio non-linear change mechanism, БУ-45А hydraulic booster and КАП-2 autopilot servo mechanism.

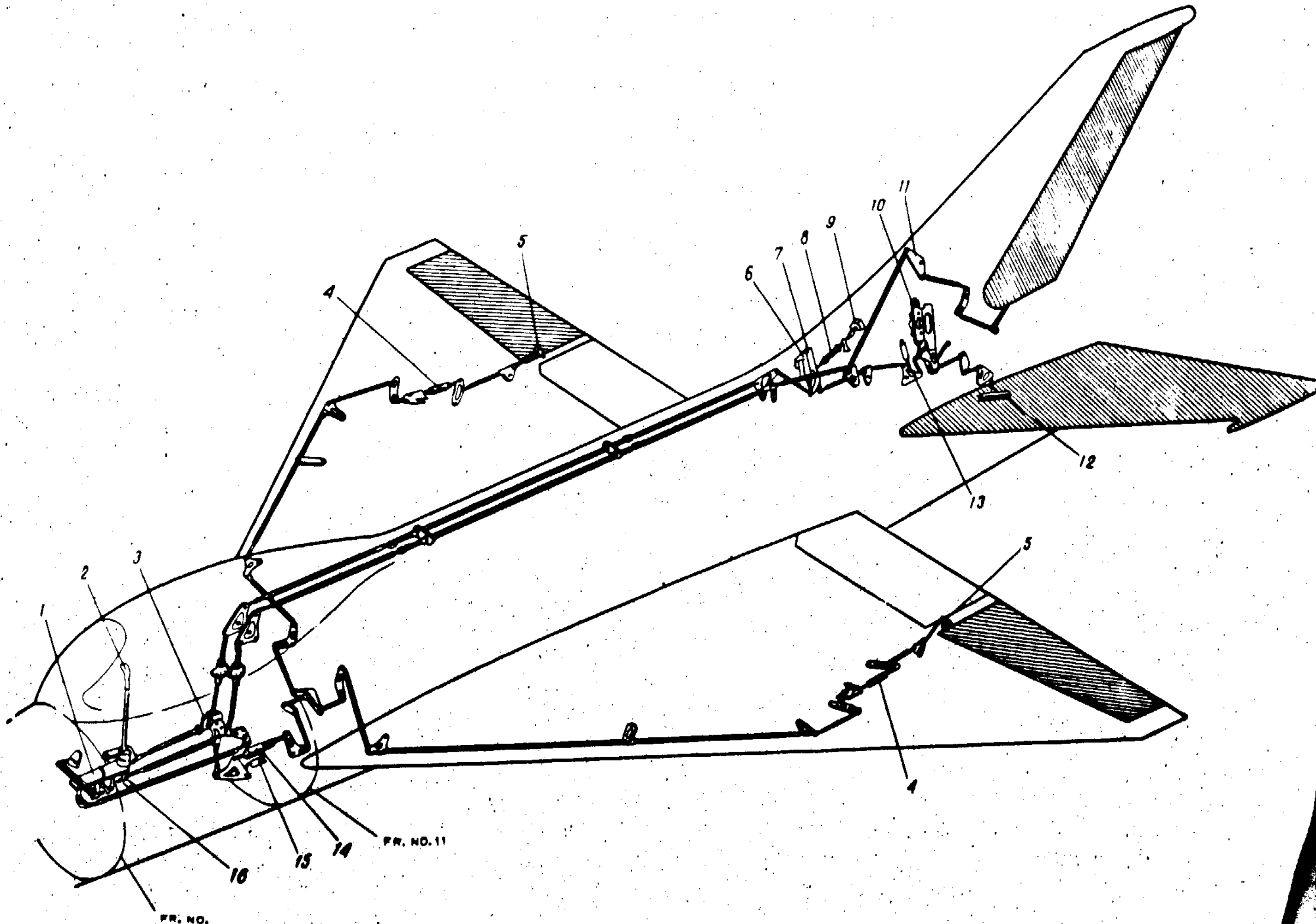


FIG.179. AIRCRAFT CONTROL DIAGRAM
1 – control assembly; 2 – control stick; 3 – non-linear aileron transmission ratio change mechanism; 4 – right and left boosters БУ-45А; 5 – aileron assembly; 6 – КПЧ-2 transmission ratio corrector; 7 – АРУ-3В automatic transmission ratio controller; 8 – stabilizer artificial feel spring mechanism; 9 – trimming effect mechanism; 10 – БУ-51МС booster; 11 – rudder control bell-crank; 12 – stabilizer crane member; 13 – ДСУ-3 [illegible]; 14 – РАУ-107 servo unit of autopilot КАП-2; 15 – beam for weight balancing of aileron control elements; 16 – aileron control spring-loaded mechanism.

When the boosters are engaged, the ailerons are deflected through an angle of $20^\circ \pm 1^\circ$ up and down, and through an angle of $20^\circ - 2^\circ$ when the boosters are disengaged.

Same as in the case with the stabilizer control system, the artifitial feel mechanism immitates the aerodynamic loads upon the control handles.

The transmission ratio non-linear change mechanism is employed to provide normal lateral control of the aircraft at high flight speeds when the ailerons effect is excessive.

The БУ-45А hydraulic booster employed in the aileron control system is connected in a non-reversible manner and responds to all hinge moments produced by the aerodynamic forces acting on the ailerons.

To mount or inspect the БУ-45А boosters, detachable hatches in the wing skin are to be removed.

The autopilot system, type КАП-2, is fitted with a servo unit, type РАУ-107. The КАП-2 autopilot is intended to improve the stability characteristics and aircraft lateral control. The autopilot can be operated in two modes:

(a) lateral damping during manual steering;

(b) flight stabilization during automatic roll-angle zeroing, zero-roll stabilization and control of the roll angle by the control stick.

3. Rudder Control System

The rudder control system is of a rod type. The control is effected through operating the foot control bars connected to the rudder by means of a system of tubular control rods, bell-cranks and levers. Maximum to-and-fro strokes of the foot control bars displaced through a length of 87.5^{+6}_{-3} mm from the neutral position cause right-hand and left-hand deflections of the rudder through an angle of $25^\circ \pm 1^\circ$.

The bell-cranks and control rods actuating the stabilizer, rudder and ailerons are mounted separately when the nose and tail sections of the fuselage and the wings are assembled. When the nose and tail sections of the fuselage are jointed abut, the control rods actuating the stabilizer and rudder are butted by means of hinge bolts near frame No.28. To provide an access to the bolts, it is necessary to remove the supersturcture of the fuselage.

When the wings are mounted, the aileron control rods are jointed near frame No.13 by means of hinge bolts coupling the rods to the bell-cranks installed inside the wings in rib 1. To provide an access the wing nose section should be removed.

The stabilizer control system is provided with a pick-up ДСУ-2 with a micro-switch, type Д703. The pick-up is mounted on the bell-crank at frame No.33 after the final adjustment of the control system. The pick-up is used for interlocking the anti-surge shutters and the cone depending on the stabilizer deflection angle.

4. Wing Flaps and Air Brakes Control System

The wing flaps are controlled electrohydraulically from the cockpit by means of changing the toggle switch over to extraction or retraction (for details, see Chapter V of the given book).

The air brakes are controlled electrohydraulically from the cockpit by means of a slide mounted on the engine control lever handle. When the slide is shifted forward or backward from the neutral position, the air brakes are retracted or extended, respectively.

II. CONTROL ASSEMBLIES

1. Central Control Assembly

The central control assembly (Fig.180) comprises the controls installed inside the cockpit. It consists of an electron alloy bracket which carries the control stick and foot control bars.

Bracket

Electron alloy bracket 4 is bolted to the cockpit floor and frame No.7B. Pressed into the bracket body are the ball bearings which support the rotatable sleeve with control stick 5 and aileron control lever 9, as well as axle 2 of main tube 15 of the parallelogram mechanism with foot control bars 1. The bracket mounts the stops which limit the travel of the foot control bars and control stick.

Foot Control Bars Parallelogram Mechanism

Rudder foot control bars 1 are hinged with bolts to the front part of the central control assembly by means of the parallelogram mechanism which consists of tube 15, connecting rod 16 and axle 2, as well as of side brackets 11.

The foot control bar consists of a foot rest, knurled plate, duralumin stem and foot straps. The foot rest with stem 12 is inserted into side bracket 11 and locked therein by means of adjusting locking screw 10.

The length of the foot control bars is adjusted to fit the pilot. The adjustment of the length is done as follows. There are six holes, dia. 6 mm., spaced at 18 to 20 mm from each other in stem 12 of the foot control bar which is rigidly attached to the foot rest by means of two taper bolts. Depending upon the pilot's height the foot control bar with the stem is drawn outside or inside relatively to the side bracket and fixed to the side bracket by means of lock inserted in the respective hole.

Rudder control rod 13 is attached at the left-hand side of lever 14 which is rigidly attached to the axle of parallelogram mechanism 2.

Aircraft Control Stick

The control stick (Fig.181) consists of three parts: aluminium alloy grip 13, duralumin tube 2 and lower sleeve 1. The grip is attached to the tube by means of a union nut and the sleeve is riveted to the tube.

The control stick carries wheel brake control lever 5 with cable 4 passing inside a Bowden sheath. Attached to the lower end of the control stick is the stabilizer control rod.

The grip of the aircraft control stick is fitted with five electrically operated buttons 6, 7, 9, 11 and 12, and two-position change-over switch 10.

Drop tank release button 6 is situated at the base of the control stick. The button is covered with cap 14. To drop the tanks, cap 14 is turned upward and button 6 is depressed.

Button 7 with firing trigger 8 is situated in front on the upper part of the grip. To fire the rockets, trigger 8 is shifted forward so that it turns and depresses button 7.

Target lock-on button 12 is situated on the left-hand side of the grip.

Two-position change-over switch 10 employed to engage the trimming effect mechanism is installed on the top of the grip. To remove the stretching thrust upon the stick, the change-over switch is turned down and to eliminate the compres-

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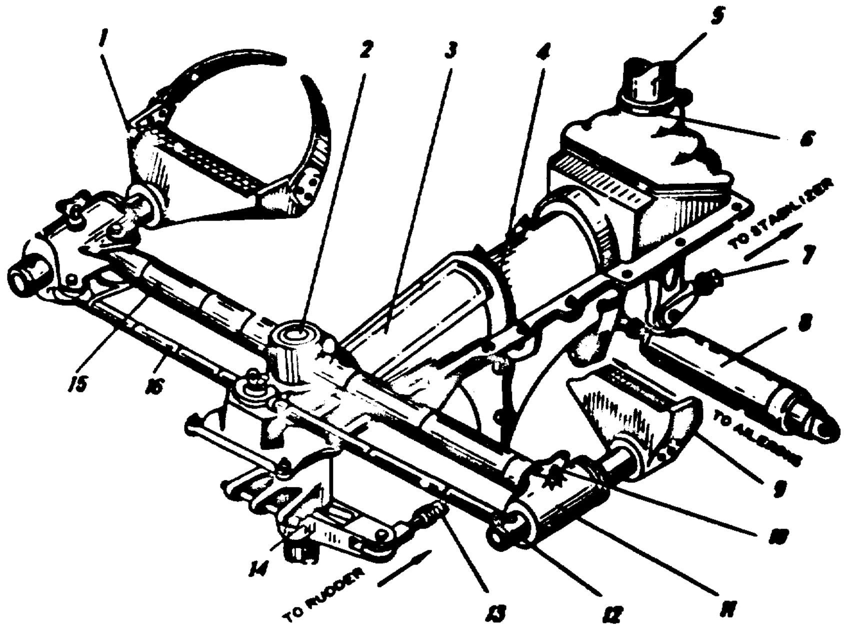

FIG.100. CENTRAL CONTROL ASSEMBLY

1 – foot control bar; 2 – axle; 3 – cover; 4 – bracket; 5 – control stick; 6 – clamp; 7 – stabilizer control rod; 8 – aileron control spring-loaded mechanism; 9 – aileron control lever; 10 – adjusting screw; 11 – side bracket; 12 – foot control bar stem; 13 – rudder control connecting rod; 14 – lever; 15 – tube; 16 – connecting rod.

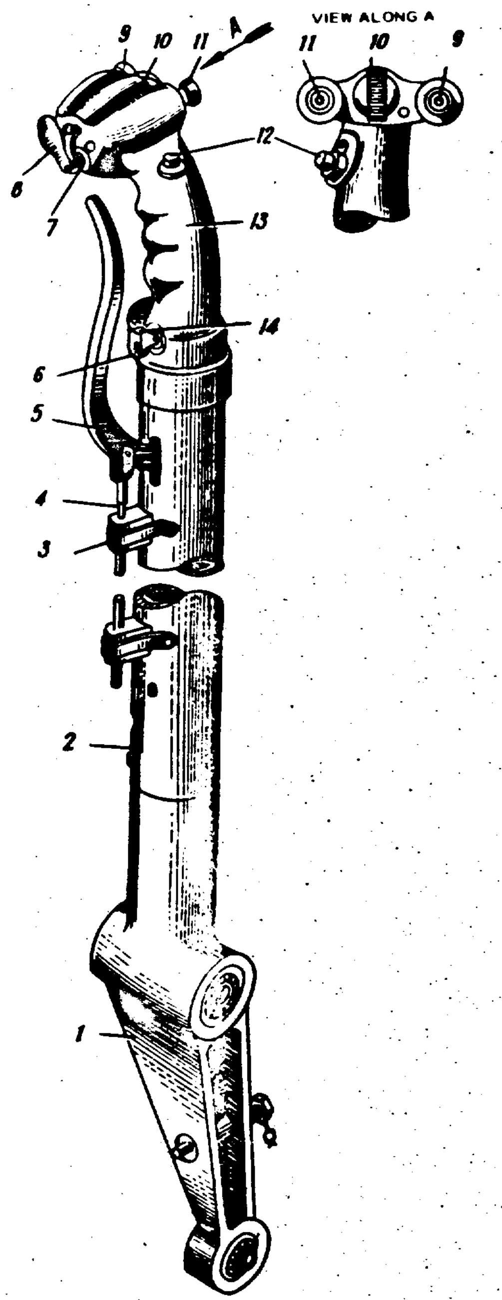

FIG. 181. CONTROL STICK
1 – stabilizer control lever; 2 – tube; 3 – cable attachment; 4 – cable; 5 – L.G. main strut wheels brake control lever; 6 – jettisonnable tank release button; 7 – firing button; 8 – trigger; 9 – KAII-2 stabilization engagement button (black); 10 – trimming effect mechanism change-over switch; 11 – KAII-2 stabilization disengagement button (red); 12 – target lock-on button; 13 – grip; 14 – jettisonnable tank release button safety cap.

sing thrust on the stick, the switch is turned upward and retained thereat as long as the thrust is not removed.

Buttons 9 and 11 are designed to engage and disengage the КАП-2 autopilot for stabilizing operation. Button 9 used for engaging the unit is black and button 11 used to cut off the unit engaged for stabilizing operation is red.

The electric cable laid inside the grip and sleeve passes outside through a hole in the sleeve.

When the stabilizer and the ailerons are in the zero position, the control stick is in its neutral position at a distance of 250 ±3 mm from the instrument.

When the stick is shifted onward from the neutral position, its travel is 220 ±14 mm and when it is shifted backward, its travel is 96 ±14 mm. When the stick is shifted left or right from the vertical position, its travel is 141 ±10 mm.

2. Sealing Arrangements of Control Assemblies

In order to prevent penetration of dirt and foreign objects, the aircraft control units are covered with protective jackets.

The control stick inside the cockpit is closed with a protective jacket and the rods controlling the stabilizer, rudder and ailerons are protected with a removable jacket of special design.

At the points where the stabilizer, rudder and aileron control rods emerge from the cockpit, sealing arrangements are installed to provide the tightness of the cockpit.

The sealing arrangements (Fig.182) of the stabilizer and rudder control rods comprise bracket 22 provided with a flange and eyelugs and rigidly attached to the fuselage, bushing 20 and packing gland 24, and bosses to receive shafts 19 (the bushing houses the tip of control rods 1 and 2), rubber jacket 25 and brace 21 used as a hinge member between bushing 20 and bracket 22. Rubber jacket 25 covers bushing 20 and the flange of bracket 22 is secured to them with wire 23. To minimize the friction between the control rod tip and bushing 20 housing the tip, the rubbing surfaces are greased with lubricant ЦИАТИМ-221.

The non-linear mechanism is installed in places where the aileron control rods emerge from the cockpit. The sealing arrangement installed where the control stick rod enters the non-linear mechanism and the control rod comes out from the non-linear mechanism to the boosters, is similar to the sealing arrangement mounted on the stabilizer and rudder control rods. The sealing arrangements installed in places where the rods come into and out of the non-linear mechanism (Fig.182) include bushings 17 and 27 with packing glands 18 and 26, sealing jackets 7 and 9 and braces 14 and 28. The non-linear mechanism housing is installed in the cockpit behind the pilot's seat. The rods connected to the bell-crank and drawn to the boosters are sealed on the cockpit floor by means of sealing jacket 11. The sealing jacket is attached to the non-linear mechanism housing and the cockpit floor by means of a wire binding.

The aileron control non-linear mechanism is covered with jackets to prevent penetration of dirt and foreign matter.

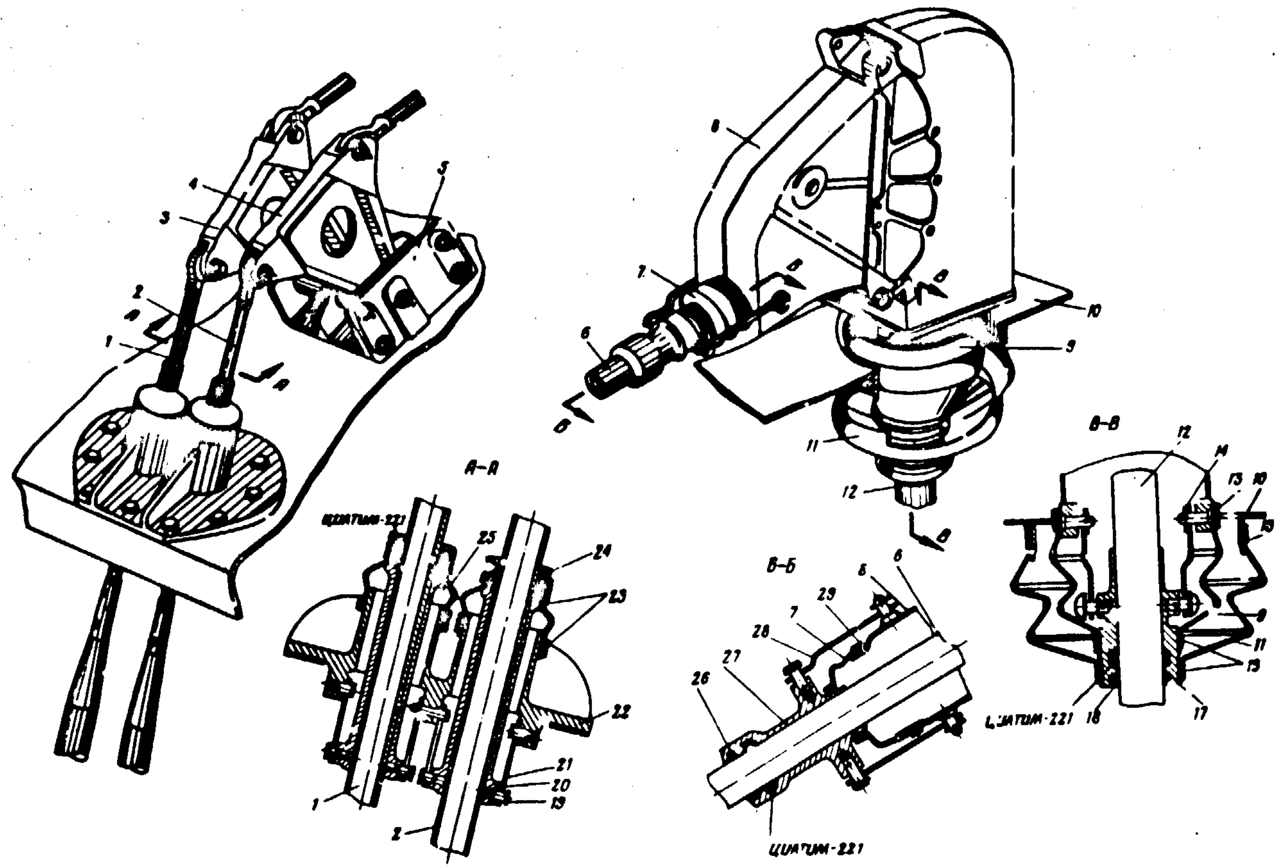

FIG.182. SEALING ARRANGEMENTS OF CONTROL ASSEMBLIES

1 – stabilizer control rod; 2 – rudder control rod; 3 – stabilizer control bell-crank; 4 – rudder control bell-crank; 5 – bell-cranks attachment bracket; 6 – control stick connecting rod; 7 – sealing jacket; 8 – non-linear transmission ratio change mechanism housing; 9 – non-linear mechanism sealing jacket; 10 – cockpit floor; 11 – aileron console outlet jacket; 12 – aileron connecting rod; 14 – brace; 13,15,16,23 – wire bindings; 17 – bushing; 18 – packing gland; 19 – shaft; 20 – bushing; 21 – brace; 22 – bracket; 24 – packing gland 25 – sealing jacket; 26 – packing gland; 27 – bushing; 28 – brace; 29 – wire binding.

III. STABILIZER CONTROL SYSTEM

1. General

The aircraft is controlled longitudinally (Fig.183) by means of the controllable (adjustable) stabilizer (with no elevator) by the aircraft control stick through a system of rigid control rods and bell-cranks by virtue of an irreversibly coupled booster, type БУ-51МС, which transmits motion simultaneously to both halves of the stabilizer.

The application of the controllable stabilizer instead of the elevator is accounted for by the fact that, in a supersonic flight and particularly at high altitudes, the elevator effect is reduced, i.e. its deflection does not cause a required change in the lift of the horizontal empennage this time. Apart from this, higher speeds increase the longitudinal static stability margin of the aircraft, which brings about an adequate increase in the force applied to its horizontal empennage for the aircraft trimming.

The use of the controllable stabilizer instead of the elevator has improved the aircraft maneuverability, since an appreciable increase in the maximum forces applied to the horizontal empennage in case the latter is deflected at supersonic speeds is accompanied by larger available load factors in the above flight conditions.

The stabilizer effect has, however, proved too high in those flight conditions when the elevator was sufficiently effective. To reduce the stabilizer effect in the conditions which render it superfluous, the aircraft is provided with an automatic transmission ratio controller, type АРУ-3В.

The transmission ratio controller system, type АРУ-3В, automatically alters the control stick-to-stabilizer transmission ratio to minimize the stabilizer deflection range and introduces simultaneous changes into the control stick-to-spring artificial feel mechanism transmission ratio, depending on the impact pressure and the flying altitude within a range from 5,000 to 10,000 m. The above changes are effected by adjusting the operating arms of the АРУ-3В automatic controller.

2. Stabilizer Control System Units and Their Purpose (Fig.184)

In addition to the aircraft control stick, the stabilizer control system incorporates the following units:

(a) artificial feel mechanism;

(b) trimming effect mechanism, type МП-100 М, 2nd series;

(c) booster, type БУ-51МС;

(d) automatic transmission ratio controller, type АРУ-3В, which is composed of a control unit, an actuating (servo) mechanism, and a position indicator.

Spring Artificial Feel Mechanism

The spring artificial feel mechanism (Fig.185) serves to simulate aerodynamic pressures on the aircraft control stick in proportion to its deflection angle as well as to the airspeed and flying altitude of the aircraft.

The artificial feel mechanism is mounted in the fuselage tail section, at its top, between frames Nos 29 and 31A.

Rod 5 of the artificial feel mechanism is coupled with the rod of the АРУ-3В automatic transmission ratio controller, while cylindrical body 8 of the mechanism is connected with the trimming effect mechanism.

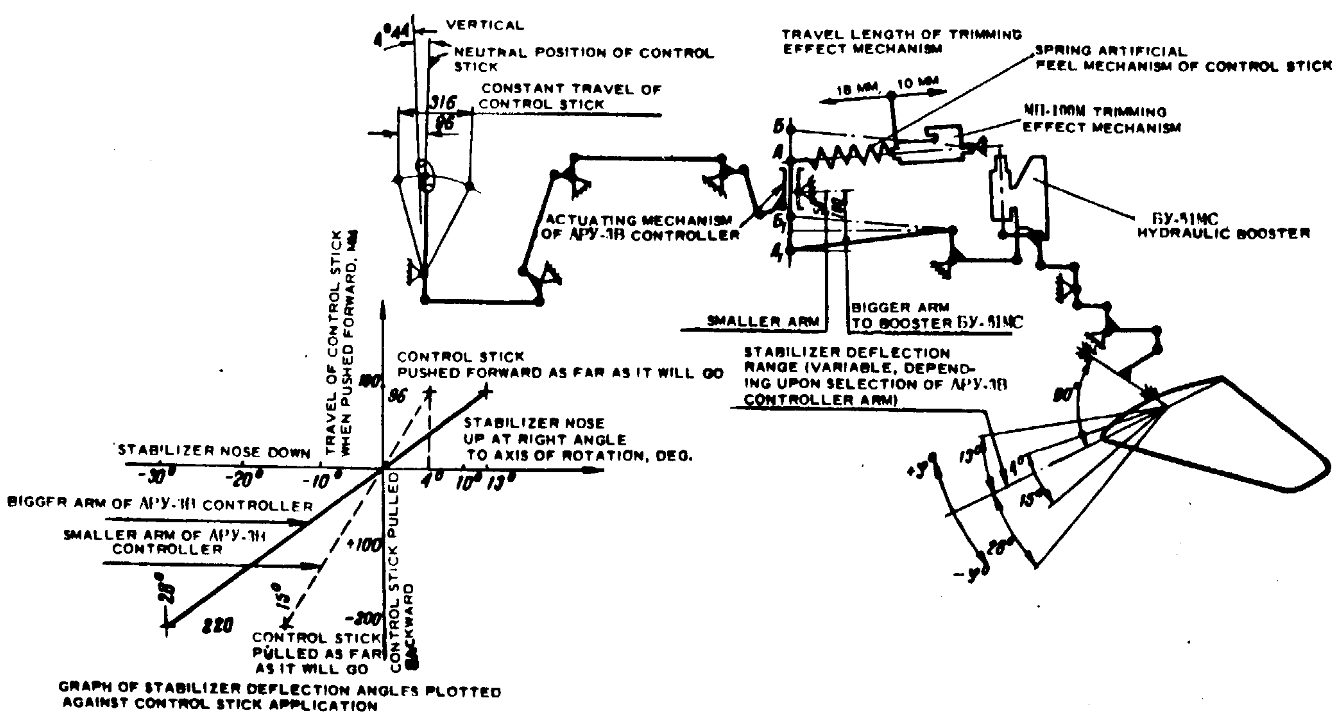

FIG. 183. DIAGRAM OF LONGITUDINAL CONTROL

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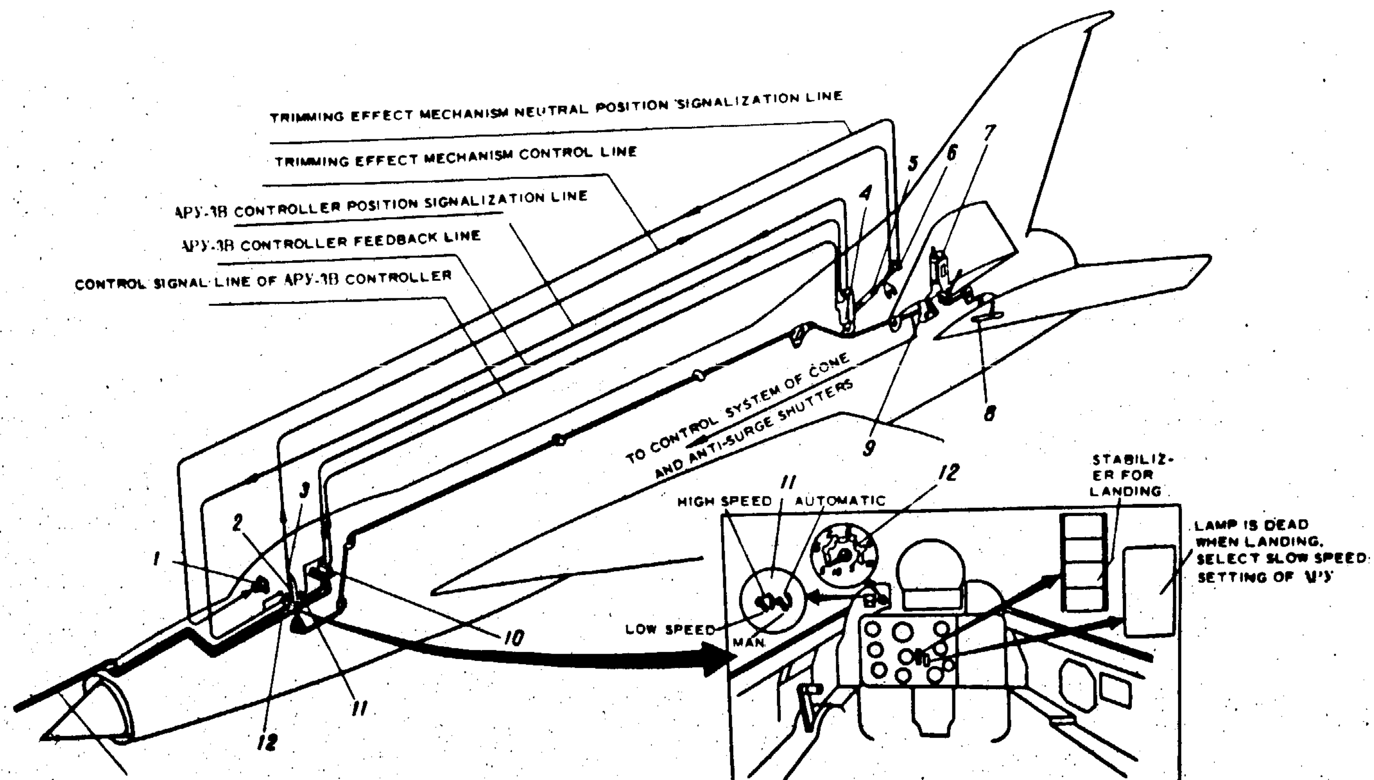

FIG.104. DIAGRAM OF STABILIZER CONTROL

1 – signal lamp on light panel T-4; 2 – aircraft control stick; 3 – control button of trimming effect mechanism; 4 – actuating mechanism of APУ-3B automatic transmission ratio controller; 5 – artificial feel mechanism; 6 – trimming effect mechanism; 7 – БУ-51MC hydraulic booster of stabilizer; 8 – stabilizer boom; 9 – ДCУ-2; 10 – control unit of APУ-3B controller; 11 – change-over switch; 12 – APУ-3B controller indicator.

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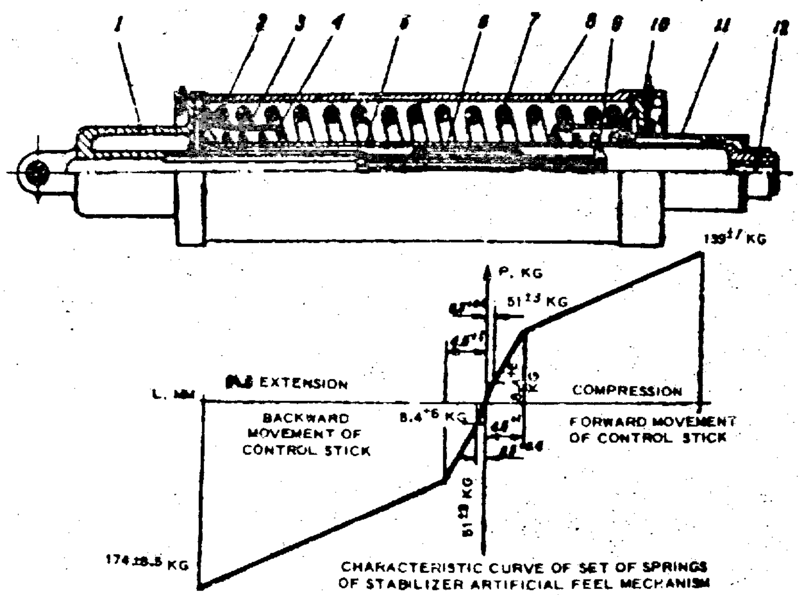


FIG.185. STABILIZER CONTROL ARTIFICIAL FEEL MECHANISM
1 – axle; 2 – washer; 3 – spring; 4 – support ring; 5 – rod; 6 – separator; 7 – spring; 8 – cylinder; 9 – nut; 10 – cover; 11 – bushing; 12 – screw.

Structurally, the artificial feel mechanism is cylinder 8 which houses axle 1 and hollow rod 5, with three pre-loaded springs installed between them.

The smaller springs are compressed by 35 kg each; as regards the middle spring, it is compressed by 42.5 kg. In the neutral position, the forces of the smaller springs are balanced, and the pressure on the rod of the artificial feel mechanism is zero.

As the АРУ-3В controller is being turned, the artificial feel mechanism rod moves into the cylinder to compress one of the smaller springs, the second smaller spring being caused to expand and a 0.5 mm travel of the rod creating a 8.4 kg effort as a result.

As the rod slides through 4.5 mm, the first spring becomes completely compressed, the second smaller spring getting fully expanded. A further travel of the rod sets in operation the middle spring only.

In case the АРУ-3В controller is operated in the reverse direction, the rod of the artificial feel mechanism leaves the cylinder and actuates the springs in the opposite direction.

The greater the deflection of the control stick, the heavier the compression of the springs and the higher the pressure on the aircraft control stick.

Trimming Effect Mechanism

The trimming effect mechanism (Fig.186) functions as an aerodynamic trimmer; the mechanism enables the pilot to adjust the neutral position of the artificial feel mechanism as he desires in order to accomplish in-flight longitudinal trimming of the aircraft in response to the existing pressures, i.e. to remove them from the aircraft control stick.

The trimming effect mechanism consists of an electric actuator, type МП-100М (2nd series), a fork and a locking washer. The actuator body is attached to a bracket installed in the furelage tail section in the region of frames Nos 31 and 32, while the rod of the actuator is secured to a bell-crank coupled with the artificial feel mechanism. The rotary motion of the electric motor of the МП-100М actuator is converted into a linear travel of the rod by a reduction gear. The rod is moved in or out, depending on the sense of rotation of the electric motor rotor and causes a displacement of the artificial feel mechanism body coupled to the rotor. When the artificial feel mechanism body is displaced by the amount of compression of the artificial feel mechanism springs, the pressure applied on the aircraft control stick will be completely removed. With the rod in one of its extreme positions (the length of the operating stroke of the trimming effect mechanism measures 18 mm from the neutral position for extension and 10 mm for retraction), microswitches installed in the electric actuator are set in operation to stop the electric motor in one of the positions.

In order to set in operation the МП-100М trimming effect mechanism, it is necessary to turn on the TRIM. EFFECT MECH. switch on the right-hand front electric board.

To actuate the signalization system of the neutral position of the trimming effect mechanism, it is required to turn on the circuit-breaker АЗС-5 bearing the inscription CHECK LIGHT PANEL, PITCH TRIM. WARNING installed on the right-hand rear electric board under a transparent cover.

The green light indicating the neutral position of the trimming effect mechanism bears the inscription TRIM. EFFECT MECH. NEUTRAL is mounted on the T-4 panel directly in the centre of the instrument panel.

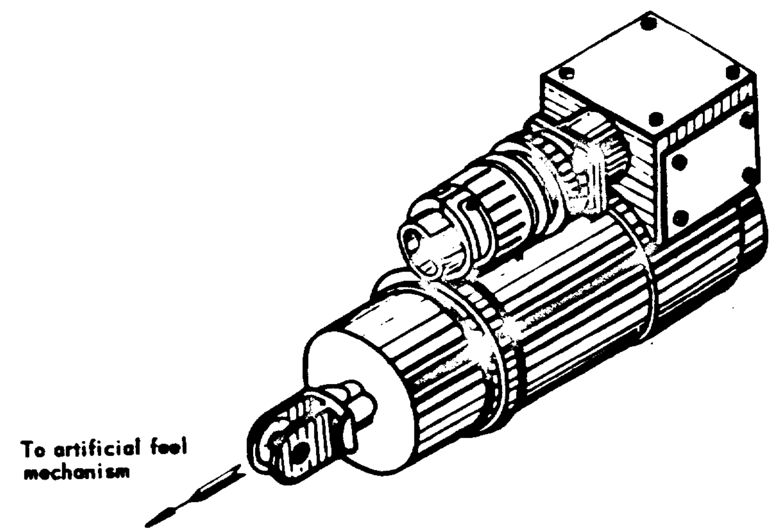


FIG.186. TRIMMING EFFECT MECHANISMS

The trimming effect mechanism is controlled with the aid of a push-type change-over switch, type ПК-4, installed on the aircraft control stick.

In order to remove the pulling or pushing pressure from the control stick, the operating button is either pushed or pulled to cause operation of the trimming effect mechanism and expansion of the springs of the artificial feel mechanism.

Hydraulic Booster, Type БУ-51МС

The booster, type БУ-51МС, operating non-reversibly, is bracket-mounted on the beam of frame No.34.

The hydraulic booster is connected to the stabilizer control system by means of a bell-crank coupled with the hydraulic booster rod and the control rods; connected from the side of the slide valve is a control rod which couples the БУ-51МС booster with the control stick.

The hydraulic booster, type БУ-51МС, is of two-chamber type; the booster is supplied with the working fluid simultaneously from two hydraulic systems: the booster and the main hydraulic systems. Each of the systems separately feeds the working fluid to the appropriate chamber of the БУ-51МС booster and also provides fluid return from its respective chamber. In case any of the hydraulic systems fails in operation, the БУ-51МС hydraulic booster keeps on operating by virtue of one of the chambers, depending on the system which remains serviceable.

Connected to the booster hydraulic system is an emergency pumping unit, type НП-27Т, which maintains a required pressure in the booster system to ensure the aircraft landing in case the hydraulic pump fails or the aircraft engine stops.

In case the pipeline of the booster hydraulic system is damaged, the pumping unit does not ensure the aircraft control.

The pumping unit is automatically engaged as soon as the pressure in the booster hydraulic system drops down to 165^{+10}_{-5} kg/cm^2. The hydraulic pump of the booster hydraulic system running, the pumping unit is automatically disengaged at an increase of pressure in the system not above 195 kg/cm^2.

In case the pressure is zero in both the hydraulic systems, the stabilizer control is made impossible due to excessively high pressures on the control stick, the pressures being beyond the physical ability of the pilot. For the design and operation of the БУ-51МС hydraulic booster see Chapter V of the present book.

3. Automatic Transmission Ratio Controller, Type АРУ-3В

The set of the АРУ-3В automatic transmission ratio controller consists of a control unit, an actuating (servo) mechanism, and a position indicator.

Control Unit

The control unit takes up dynamic and static pressures from the pitot-static tube and works out a control program according to changes in the current values of the ram (impact) pressure and altitude, with the control signal being subsequently sent to the actuating (servo) mechanism.

The control unit comprises the following components:

(a) ram pressure pick-up, type МРД-106, which converts the physical ram pressure from the pitot-static tube into electrical voltage;

(b) altitude pick-up, type МРД-126, which converts the physical static pressure from the pitot-static tube into electrical voltage;

(c) polarized relay, type РПС-5, which sums up the ram pressure, static pressure and feedback signals and, in the case of their mismatch, applies a polar control signal to the power relays;

(d) a pair of power relays, type РС-3, which amplify the power between the polarized relay and the electric motor.

Actuating Mechanism

The actuating mechanism (Fig.187) follows up the rod movement control signal in order to introduce changes into the control stick-to-stabilizer and control stick-to-artificial feel mechanism transmission ratios and transmits the feedback signal of the rod position into the control unit and position indicator.

The actuating mechanism incorporates the following components:

(a) linear-action electric actuator, type МП-100МА, which converts a signal from the power relays into mechanical motion of the actuating mechanism rod;

(b) feedback potentiometer which converts the mechanical motion of the actuating mechanism rod into an electrical voltage to generate a feedback signal to be applied to the polarized relay;

(c) position indicator potentiometer which converts the mechanical motion of the actuating mechanism rod into an electrical voltage to generate a signal applied to the position indicator.

The position indicator orients the pilot as to whether the program of control in response to the ram pressure (indicated airspeed) and flying altitude is properly carried out; to this end, the indicator converts the electrical voltage from the potentiometer of the actuating mechanism rod into the pointer mechanical motion.

Interaction of АРУ-3В Components

With the АРУ-3В automatic transmission ratio controller in operation, the automatic controller units interact in the following way (Fig.188):

(a) in response to variations (increase or decrease) in the airspeed or altitude, the electrical voltage is supplied from the pick-ups to the windings of the polarized relay, type РПС-5;

(b) the instant the voltage stored up in the РПС-5 relay windings in response to the airspeed changes becomes equal to the actuating current of the polarized relay, the central contact of the relay is made close to one of its side contacts;

(c) the central contact closed to the side one in the polarized relay, one of the power relays, type РС-3, picks up as a result;

(d) the engaged relay, type РС-3, operates to connect the electric motor of the МП-100МА actuator and to release its coupling at the same time;

(e) the electric motor of the МП-100МА actuator drives the actuating rod of the АРУ controller to change, firstly, the control stick-to-stabilizer and control stick-to-spring artificial feel mechanism transmission ratios and, secondly, move the slides of the feedback and position indicator potentiometers;

(f) electrical voltage is applied from the feedback potentiometer to the winding of the polarized relay, type РПС, to saturate it with a current of reverse polarity with respect to the pick-up current;

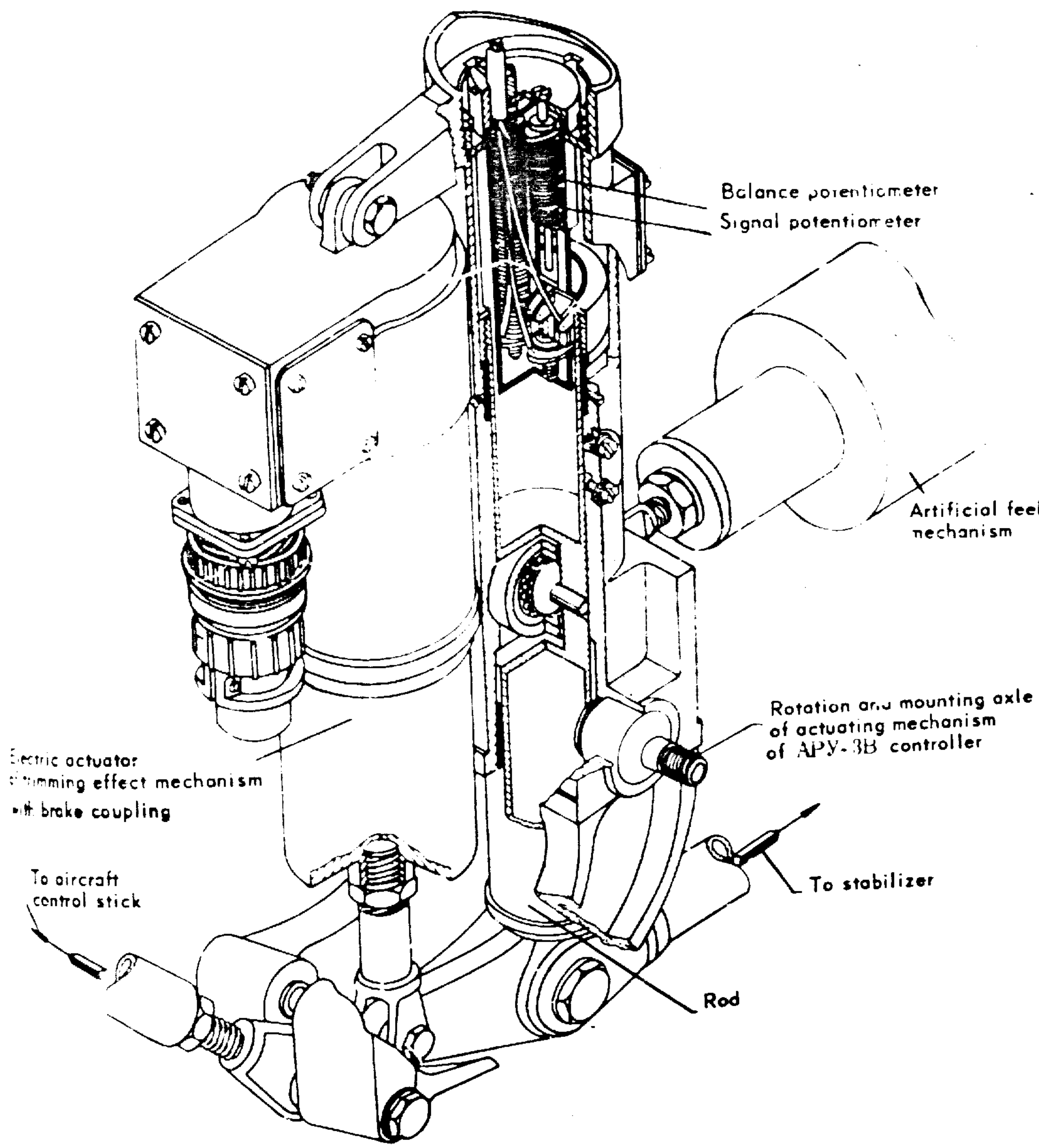


FIG.187. ACTUATING MECHANISM OF APУ-3B CONTROLLER

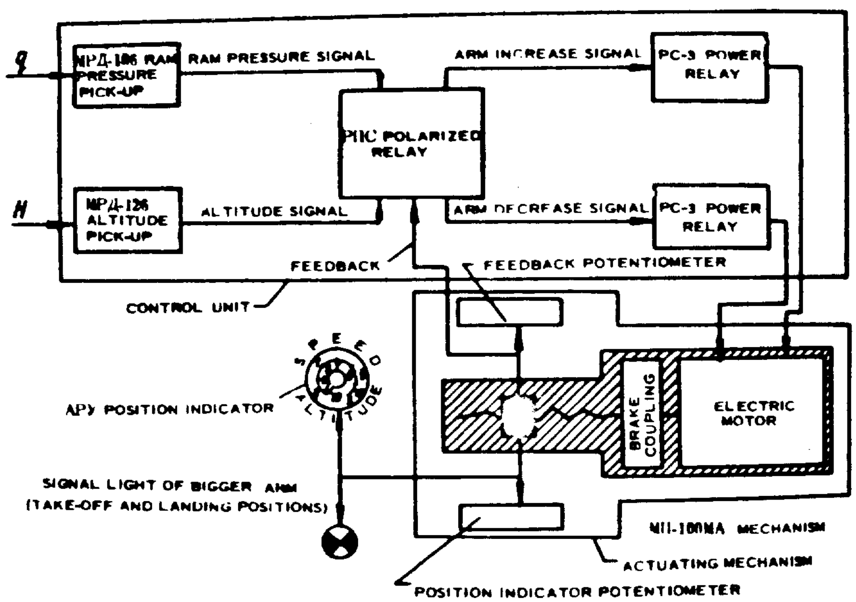


FIG.188. DIAGRAM OF APY-3B CONTROLLER UNITS

(g) the moment the currents in the relay and pick-up attain balance or, else, the feedback current becomes slightly larger than the pick-up current, the contacts of the PПC relay become open;

(h) the contacts of the PПC-5 relay open, the power relays, type PC-3, are caused to disengage as a result; the electric motor of the MП-100MA actuator together with its brake coupling is de-energized, the latter abruptly stopping the actuating rod.

Thus, the APУ-3B automatic controller units operate in steps (intermittent engagement cycles) in response to gradual changes in the ram pressure or flying altitude within the limits of the control law.

The number of engagement cycles within the control range in response to changes in the ram pressure and flying altitude is so selected that the operation steps could be perceived by the pilot in flight to a least possible extent and the operating modes of the controller relays were of minimum heaviness.

Characteristic Features of APУ-3B Controller Operation and Its Control Program

The aircraft stability and controllability are greatly influenced by the ram pressure and flying altitude. As is seen from Fig.189, at one and the same high ram pressure, the amounts of the control stick application required to build up a unit load factor by deflecting the stabilizer when piloting the aircraft vary with the flying altitude. At a low ram pressure, the aircraft controllability is negligibly affected by the flying altitude. Consequently, the aircraft piloting technique is largely varied to meet different flight conditions.

It will also be noted from Fig.189 that the APУ-3B system control program should be accomplished with due regard to the current values of the ram pressure and flying altitude in order to compensate for effects the flight conditions produce on the aircraft controllability.

Fig.190 demonstrates that at altitudes from 0 to 5 km. the APУ-3B controller arm adjustments required to fully make up for the necessary deflections of the stabilizer on the control stick almost do not differ from each other; therefore, it is only the airspeed which makes it necessary to adjust the arm of the APУ-3B controller at the above altitudes.

In this case the airspeeds lower than 455 km/hr and higher than 992 km/hr are characterized by constant stick-to-spring feel mechanism and stick-to-stabilizer transmission ratios which correspond respectively to minimum or maximum pressures on the control stick and to maximum or minimum deflection angles of the stabilizer.

As is seen from the same figure, the accepted law of control of the APУ-3B automatic controller units averages the required adjustments of the booster line arm.

When flights are performed at altitudes from 5 to 10 km., the controller system operation depends both on the ram pressure and the flying altitude. An increased altitude brings about a reduction in the range of the controller operation in response to the ram pressure. The pressures on the control stick are relieved, while the stabilizer deflection per degree of the stick movement is increased.

An introduced altitude correction is function of variations in the aircraft stability and controllability which are governed by ever-increasing flying Mach numbers and by a reduced stabilizer effect.

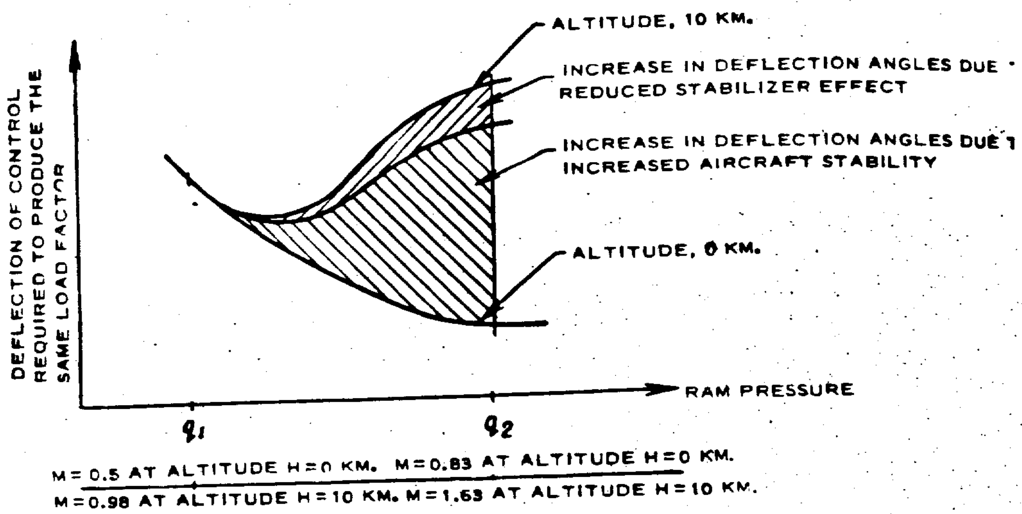


FIG.189. AIRCRAFT CONTROL Vs RAM PRESSURE, STATIC STABILITY MARGIN AND STABILIZER EFFECT

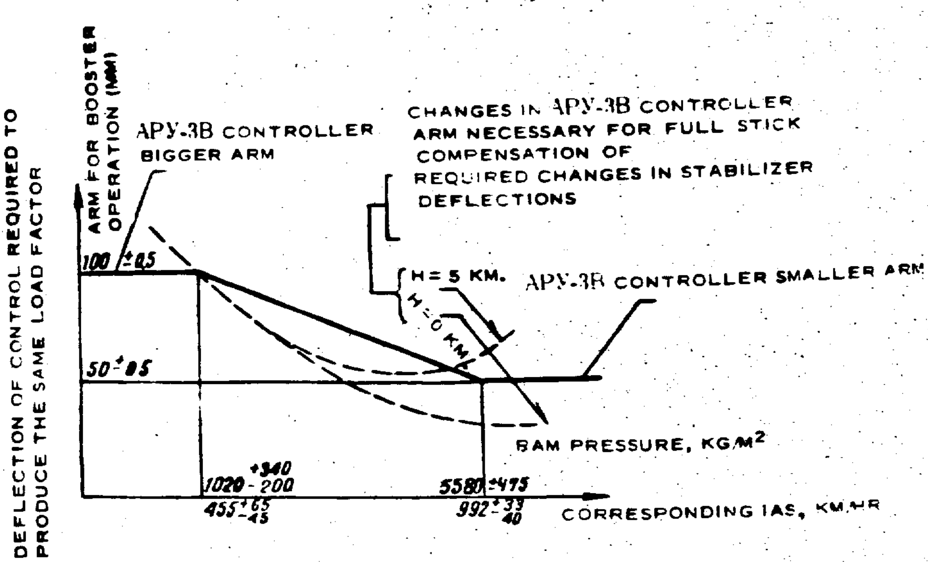


FIG.190. APY-3B CONTROLLER ARM FOR BOOSTER OPERATION Vs RAM PRESSURE AT ALTITUDES FROM 0 TO 5 KM.

Fig.191 presents the law of control of adjustments to be made for the APУ-3B controller arm at an altitude of 7 km.

At altitudes above 10 km., irrespective of the airspeed as well as at an indicated airspeed less than 455 km/hr irrespective of the altitude, the controller system is disengaged. In this case, the stick-to-artificial feel mechanism and stick-to-stabilizer transmission ratios come to correspond respectively to the minimum stick loading and maximum deflection angles of the stabilizer.

The assumed control law (program) of the APУ-3B controller averages a complex relation of the required motions of the actuating mechanism rod of the APУ-3B controller, depending on the ram pressure and flying altitude. The above-mentioned averaging ensures a sufficient compensation for excessive effect of stabilizer deflection and adds to a greater standardization of the aircraft piloting techniques within a broad range of airspeeds and flight altitudes.

The law assumed for control of the APУ-3B controller actuating rod is presented in Fig.192.

When the actuating mechanism rod (Fig.183) travels from position A-A_1 (the bigger arm engaged for the operation of the БУ-51МС booster) to position Б-$Б_1$ (the smaller arm engaged for the booster operation), the two transmission ratios, the control stick deflection being invariable, suffer the following changes:

(a) firstly, a change in the control stick-to-stabilizer transmission ratio which causes a reduction in the stabilizer deflection range at the expense of the decreased booster line arm (О$Б_1$ instead of ОA_1);

(b) secondly, a change in the control stick-to-spring artificial feel mechanism transmission ratio which brings about an increased pressure on the control stick due to the increased artificial-feel mechanism arm (ОБ instead of ОА).

A change-over from the bigger to the smaller arm of the APУ-3B controller actuating mechanism rod causes a change in the stabilizer deflection angles in response to the control stick application. Similarly, a change is introduced in the pressures on the control stick in case the latter is deflected from the neutral position as is shown in Fig.193.

The operating travel of the trimming effect mechanism for extension is 18 mm from the neutral position and 10 mm for retraction. The travel range and time (in sec.), during which the pressures on the control stick undergo changes to follow the full travel of the trimming effect mechanism rod from the neutral position, with the bigger arm of the APУ-3B controller selected, are presented in Fig.194, and with the smaller arm selected, in Fig.195.

The above figures indicate that as regards the pressures, the neutral position of the control stick and that of the МП-100М trimming effect mechanism do not match the neutral position of the stick when the stabilizer deflection angle is equal to zero.

This is accounted for by the fact that the instant the БУ-51МС booster is engaged, with the trimming effect mechanism being set in the neutral position and the control stick released, the booster will operate on the APУ-3B bigger arm and the stabilizer nose will be moved upward through 10 ±2 mm (for balancing at flying speeds V=750 km/hr).

Besides, the downward deflection of the stabilizer nose, with the control stick released, depends on the accuracy of the trimming effect mechanism adjustment.

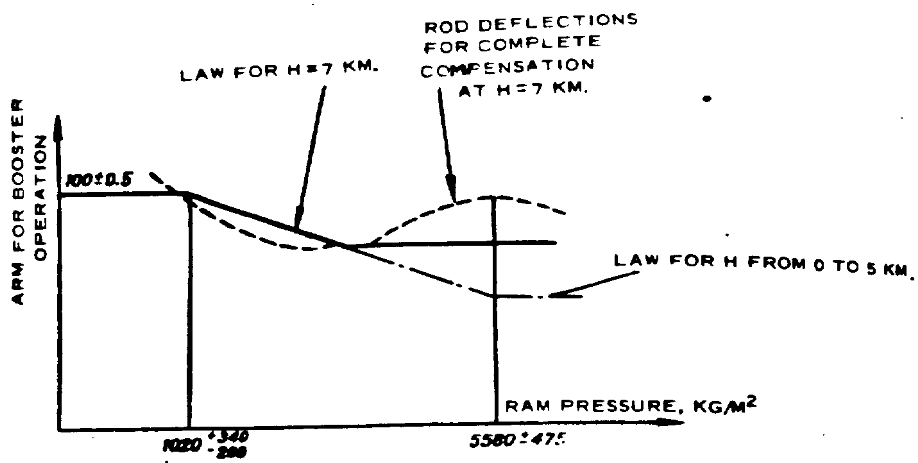


FIG.191. APY-3B CONTROLLER ARM FOR BOOSTER OPERATION Vs RAM PRESSURE AT ALTITUDE OF 7 KM.

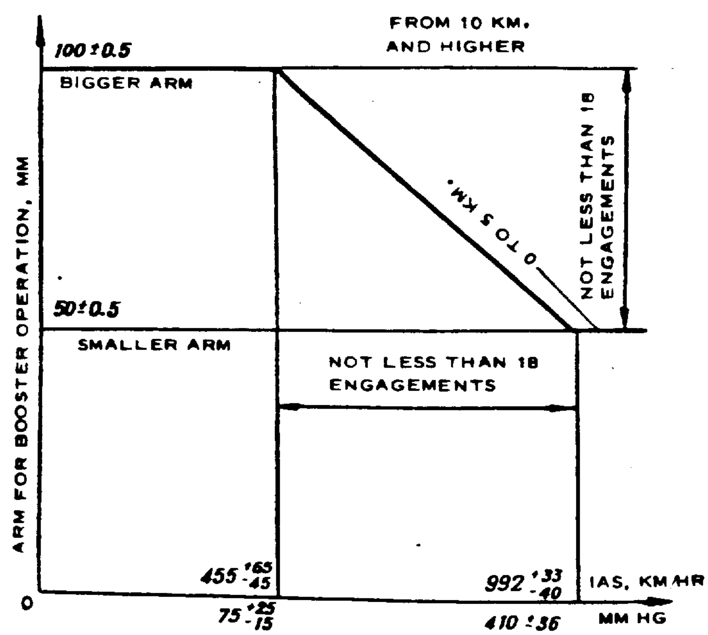


FIG.192. ASSUMED LAW FOR ADJUSTING APY-3B CONTROLLER ACTUATING MECHANISM ROD ARM ENGAGED FOR BOOSTER OPERATION:

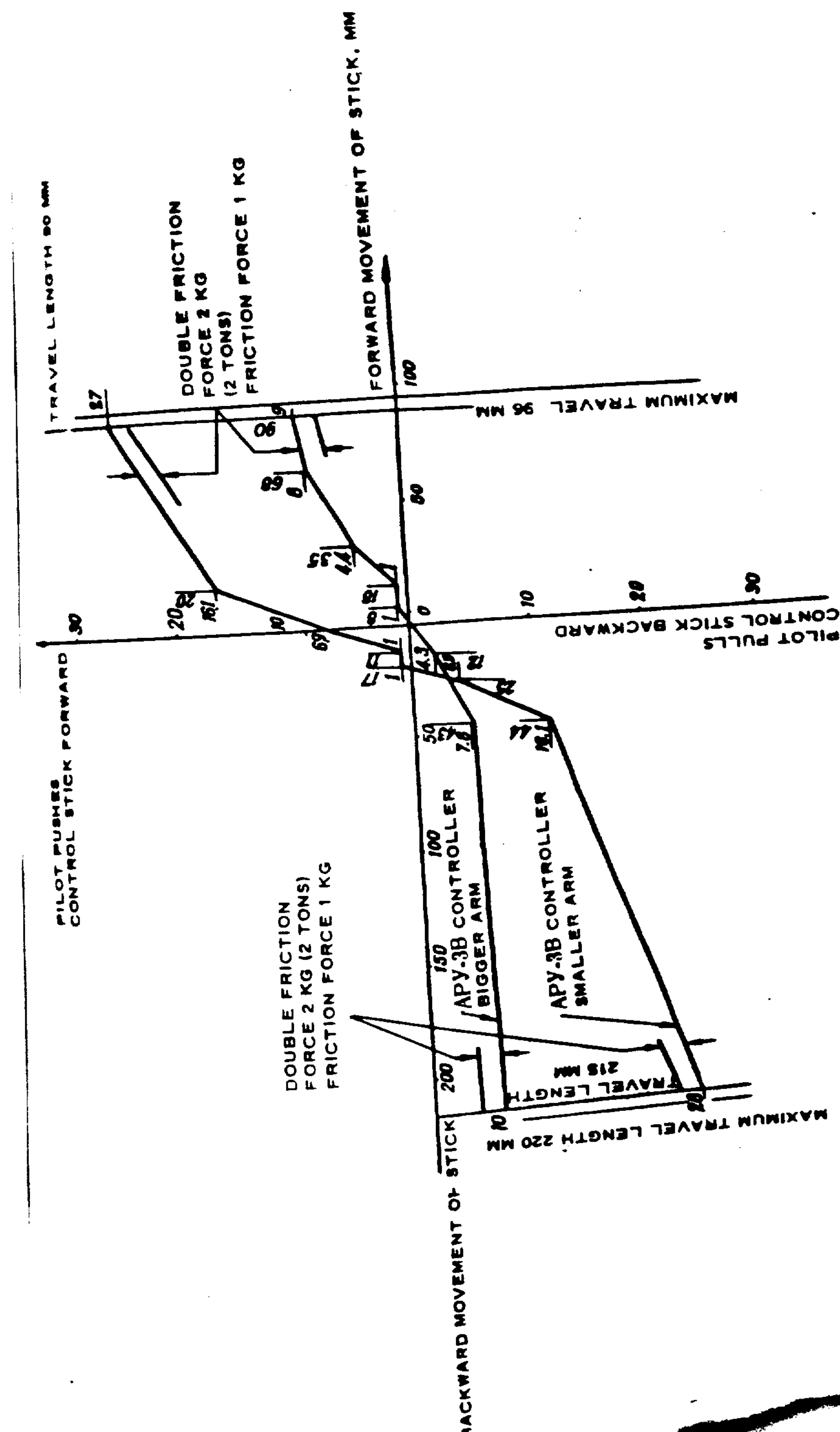


FIG.193. STABILIZER DEFLECTION ANGLES VS CONTROL STICK LOADING AND PRESSURE IN OFF-NEUTRAL POSITION

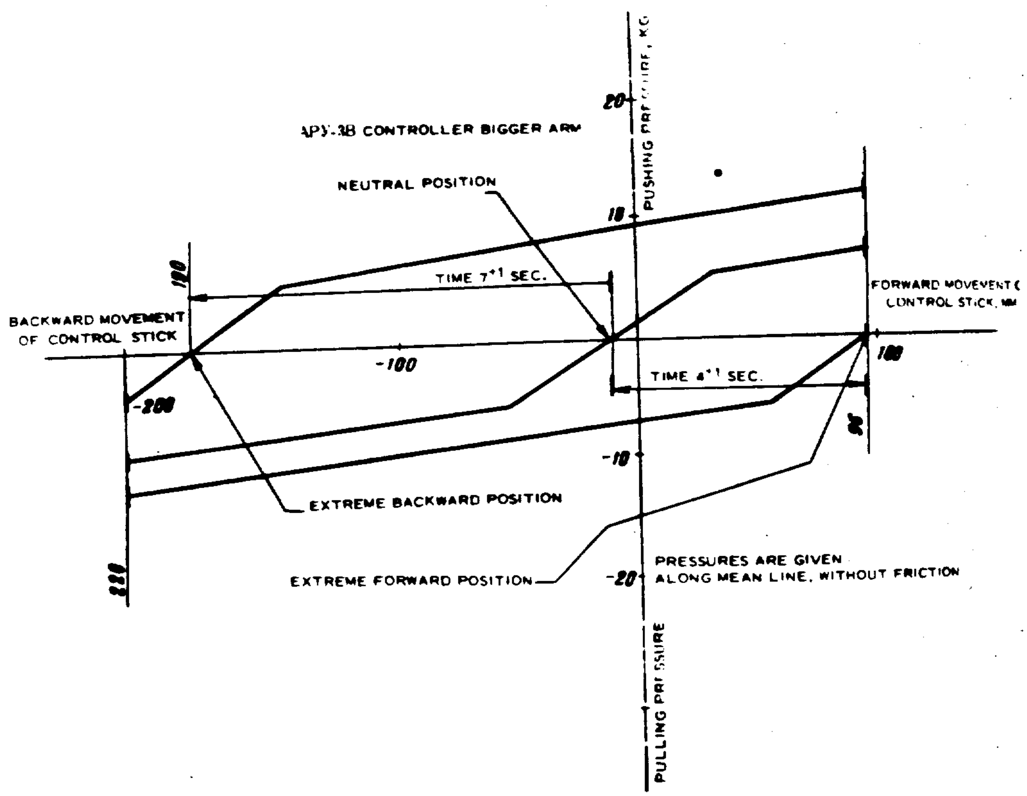


FIG.194. RANGE AND TIME OF CONTROL STICK PRESSURE VARIATIONS AT FULL TRAVEL LENGTH OF TRIMMING EFFECT MECHANISM ROD FROM NEUTRAL POSITION WITH BIGGER ARM OF APY-3B CONTROLLER

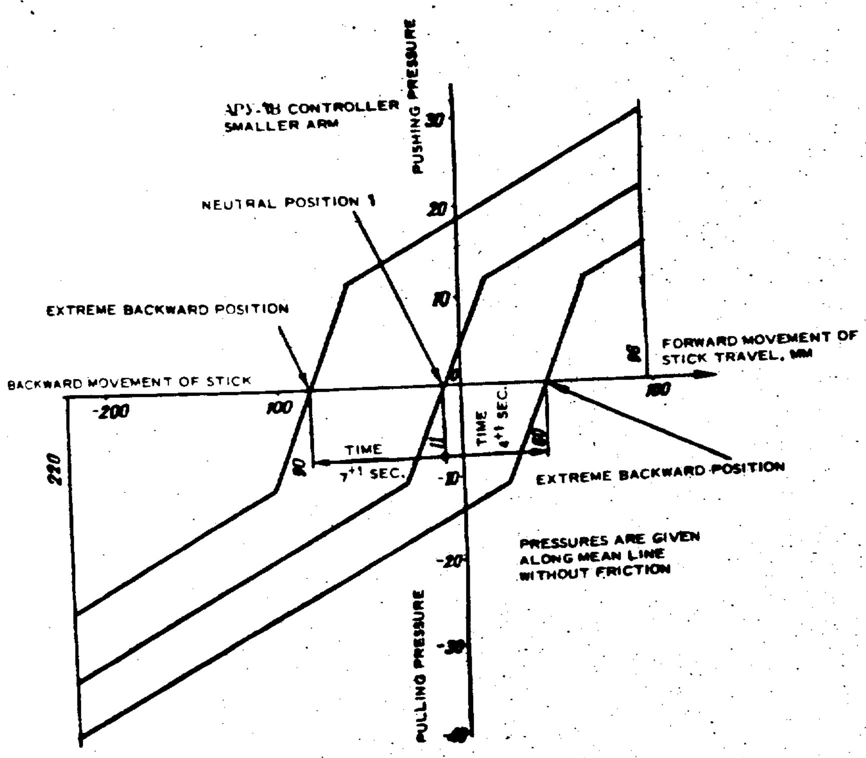


FIG.195. RANGE AND TIME OF CONTROL STICK PRESSURE VARIATIONS AT FULL TRAVEL LENGTH OF TRIMMING EFFECT MECHANISM ROD FROM NEUTRAL POSITION WITH SMALLER ARM OF APY-3B CONTROLLER

The МП-100М trimming effect mechanism is provided with a lamp whose glowing indicates the neutral position within 0.5 to 2.0 mm of the rod travel; this corresponds to a 5- to 20-mm travel of the released control stick in case the bigger arm of the АРУ-3В controller is selected, and to the time during which the lamp is on for 0.3 to 1.0 sec. of the rod travel.

Therefore, in order to obtain an accurate neutral position of the trimming effect mechanism, type МП-100М, 2nd series, the rod should be placed in the mid of the lamp burning period.

Indicating and Control Instruments of АРУ-3В Automatic Controller

The system of the АРУ-3В indicating and control instruments comprises the АРУ-3В controller position indicator, indicating lights, and a toggle switch of the АРУ-3В automatic and manual control.

The АРУ-3В controller position indicator is mounted on the left-hand board of the instrument panel and has two scales: one of the scales indicates the operation of the automatic controller as a function of variations in the flying speed, while the other scale is used to indicate the АРУ-3В operation as a function of a varying flying altitude.

The outer scale reads (clockwise) airspeed values and the inner scale carries (counter-clockwise) altitude values.

As the actuating rod of the АРУ-3В controller moves, the voltage set up in the position indicator potentiometer drives the pointer of the position indicator installed in the aircraft cockpit.

The position indicator readings enable the pilot to judge whether the automatic control system operates in accordance with the preset control law or not. If the operation is proper, the indicator reads as follows (Fig.196):

(a) when in flight at an indicated airspeed less than 455 km/hr (i.e. before the АРУ-3В controller system is set in operation), the pointer of the position indicator rests against the left stop (position 1 in Fig.196);

(b) when flight is made at altitudes ranging from 0 to 5 km. and at indicated airspeeds measuring from 455 to 992 km/hr, the position indicator pointer swings across the airspeed scale, with its readings approximately coinciding with those of the airspeed indicator; however, at speeds higher than 992 km/hr, the pointer remains at the right-hand stop (position 2 in Fig.196);

(c) when flying at altitudes from 5 to 10 km. and indicated airspeeds from 455 to 992 km/hr, the position indicator pointer sweeps the airspeed scale until it reaches the mark inscribed on the altitude scale. The altitude mark serves as the right-hand stop for the position indicator pointer (position 3 in Fig.196);

(d) when in flight at altitudes of 10 km. and higher, irrespective of the indicated flying airspeed, the position indicator pointer remains at the left-hand stop (position 1 in Fig.196).

The left-hand stop of the pointer corresponds to the take-off and landing position of the АРУ-3В controller system (the bigger arm of the booster operation) and in addition to the position indicator, is checked by the green indicator light bearing the inscription STABILIZER FOR LANDING and installed on the T-4 signalization board of the instrument panel. Provided beside the board is an instruction plate which carries: IF LAMP IS DEAD WHEN LANDING, SELECT SLOW SPEED SETTING OF АРУ.

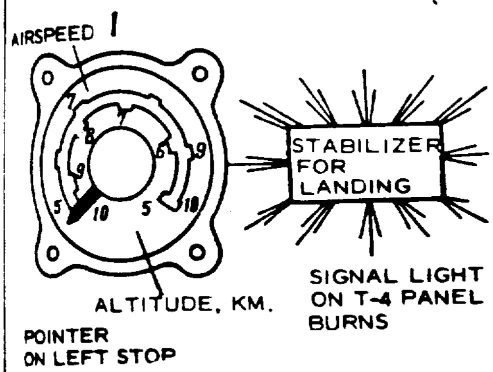
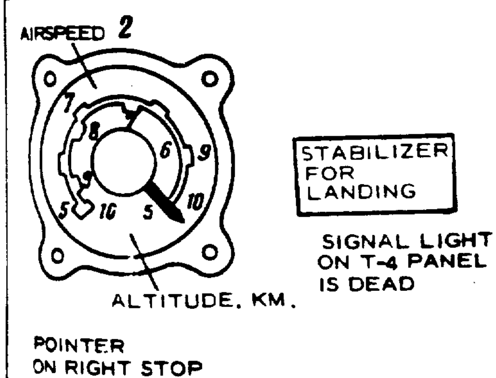
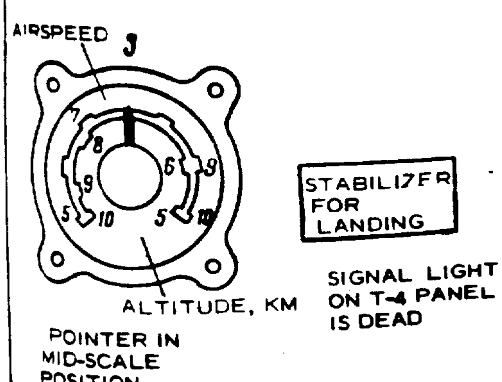
MEANS OF CHECKING OPERATION OF АРУ-3В CONTROLLER (2ND SERIES)	FLIGHT PROCEDURES
	1 – FLIGHT AT IAS LESS THAN 455 KM/HR AT ALL ALTITUDES 2 – FLIGHT AT IAS MORE THAN 455 KM/HR, AT 10-KM. ALTITUDE AND HIGHER 3 – IN LANDING APPROACH
	FLIGHT AT IAS HIGHER THAN 992 KM/HR AT ALTITUDES FROM 0 TO 5 KM.
	FLIGHT AT IAS HIGHER THAN 750 KM/HR AT ALTITUDE OF 7 KM.

FIG.196. POSITION INDICATOR OF АРУ-3В CONTROLLER

In case the actuating mechanism rod is shifted from the bigger to smaller of the booster operation, the green light comes off. It is only under standard atmospheric conditions (the ground level temperature is 15° at a static sea-level pressure of 760 mm of mercury) that a full coincidence of the position indicator readings, provided the APУ-3B controller system properly operates, with those of the flight control instruments of the aircraft (I.A.S. and T.A.S. indicator and two-pointer altimeter) is obtained. In all other cases, the readings of the APУ position indicator will differ from those of the flight control instruments, the difference being particularly noticeable in altitude indication.

That is the reason why the APУ-3B controller position indicator is used by the pilot only for general orientation as to the operation of the automatic controller system. Minor differences between the readings of the position indicator and those of the flight control instruments are not indicative of faults in the action of the automatic controller system.

The automatic control operating duty of the APУ-3B controller system is switched on by closing the A3C-5 circuit breakers bearing the inscriptions APУ AUTOM. CONTROL and APУ MANUAL CONTROL, the circuit-breakers being installed on the right-hand rear electric board in the cockpit (under a transparent cover).

The operating mode of the APУ-3B controller system is selected by means of the two-position change-over switch of the APУ controller mounted on the left-hand electric board in the cockpit and bearing the inscription AUTOMAT and MANUAL.

Normally, the operating mode selector switch of the APУ-3B controller system is placed to AUTOMAT and locked in this position with a wire, type KO-KO.3. The locking arrangements prevent taking off and flying with the APУ-3B controller set in the manual control duty and when the rod of the actuating mechanism is in the take-off and landing positions.

Ordinarily, the APУ-3B controller system does not require special in-flight control, except those cases when control is needed over the accomplishment of the control law by the system, the check being carried out by the position indicator and the green light. However, to meet failures in the action of automatic control circuits, the system is provided with manual control arrangements including a push-type manual control change-over switch.

The manual control operating duty is switched on by means of a special APУ-3B system selector switch which is locked in the automatic control position to prevent taking-off and flying with the controller kept in the manual control duty, as has been stated above.

In case the selector switch is set to MANUAL, the automatic control unit is de-energized, and the МП-100МА electric actuator is controlled directly with the aid of a push-type change-over switch installed in the cockpit.

In such a case, the position indicator and the signal light continue to operate in the cockpit, which allows the pilot to manually set the actuating mechanism rod in a position required for performing the flight.

During ground checks of the manual control circuits or in case the manual control system is deliberately set to MANUAL in flight, the movements of the rod of the APУ-3B controller actuating mechanism are controlled by use of a push-type three-position change-over switch located on the left-hand electric board which bears the inscriptions HIGH SPEED and LOW SPEED. In this control duty, the engagement of the change-over switch in the LOW SPEED direction results in extension of the rod of the APУ-3B controller actuating mechanism for the bigger arm booster operation and cutting in the switch in the HIGH SPEED direction initiates retraction of the actuating mechanism rod for the smaller arm booster operation.

When the APY controller is engaged for automatic control, the HIGH - LOW SPEED change-over switch is de-energised.

IV. RUDDER CONTROL

1. General

(Fig.197)

The rudder control system (Fig.197) is rigid and incorporates no hydraulic boosters. The control is effected by the pilot the instant he presses the pedals joined to the rudder through tubular control rods and bell-cranks. The rudder is deflected through $25^{\circ} \pm 1^{\circ}$ to the left and to the right of the neutral position. The bell-cranks are stamped of aluminium and magnesium alloys.

2. Mounting

The rudder is connected through a set of control rods to a lever which is secured on the pedal fulcrum (foot control bar axle).

The rods of the rudder control system are laid in the cockpit to pass under and behind the ejection seat, in the recess of the fuselage superstructure and in the root section of the fin.

The rudder control bell-cranks are mounted together with the stabiliser control bell-cranks in common assemblies, except the bell-cranks in the fin. In the fuselage superstructure recess, the rudder control rods together with the stabiliser control rods are secured in special supports.

V. AILERON CONTROL SYSTEM

1. General

The aileron control system (Fig.198) consists of control rods, bell-cranks, artificial feel mechanism, a transmission ratio non-linear change mechanism, two hydraulic boosters, type БУ-45А, and an autopilot, type КАП-2.

With the hydraulic boosters engaged for operation, the ailerons are deflected upwards and downwards through $20^{\circ} \pm 1^{\circ}$ and through $20^{\circ}_{-2^{\circ}}$ in case the boosters are disengaged.

The aileron control bell-cranks are installed in the aircraft fuselage and wings.

2. Aileron Control System Units

Hydraulic Boosters, Type БУ-45А

The hydraulic boosters, type БУ-45А, are installed in each wing and pin-mounted on rib No.6. The boosters are accessible through the service hatches provided in the bottom skin of the wing.

The hydraulic boosters operate non-reversibly and are supplied either from the booster or from the main hydraulic systems, i.e. the hydraulic boosters are re-connected for supply from the main hydraulic system in case the booster hydraulic system fails in operation.

The transfer to the main hydraulic system supply is automatically effected the moment the pressure in the booster hydraulic system drops to a value which is approximately equal to half the pressure maintained in the booster control main

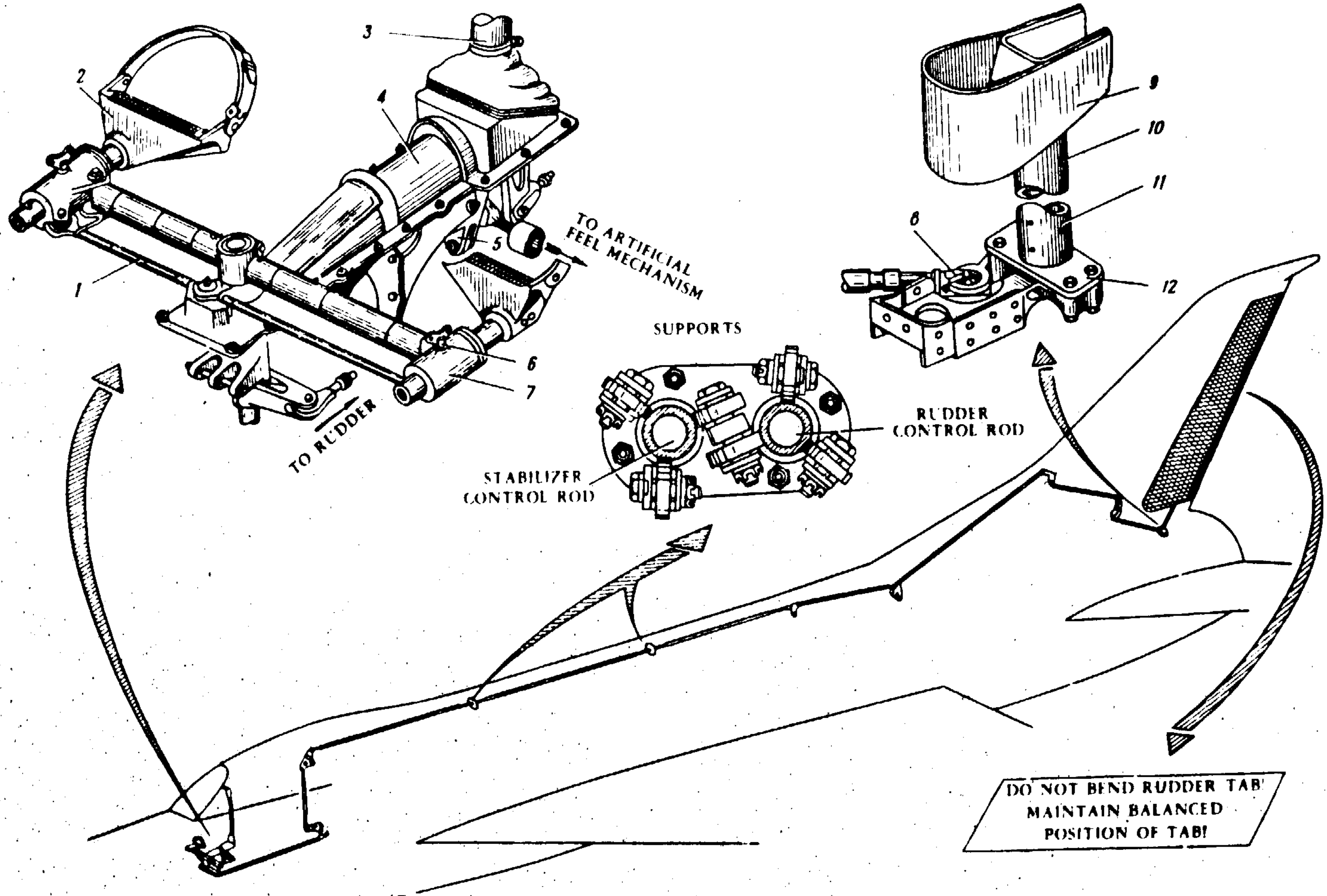


FIG. 197 RUDDER CONTROL SYSTEM

1 - connecting rod; 2 - foot control bar; 3 - control stick; 4 - bracket; 5 - aileron control lever; 6 - adjusting bolt; 7 - side bracket; 8 - bell-crank; 9 - rudder; 10 - axle; 11 - rudder lower unit; 12 - bracket.

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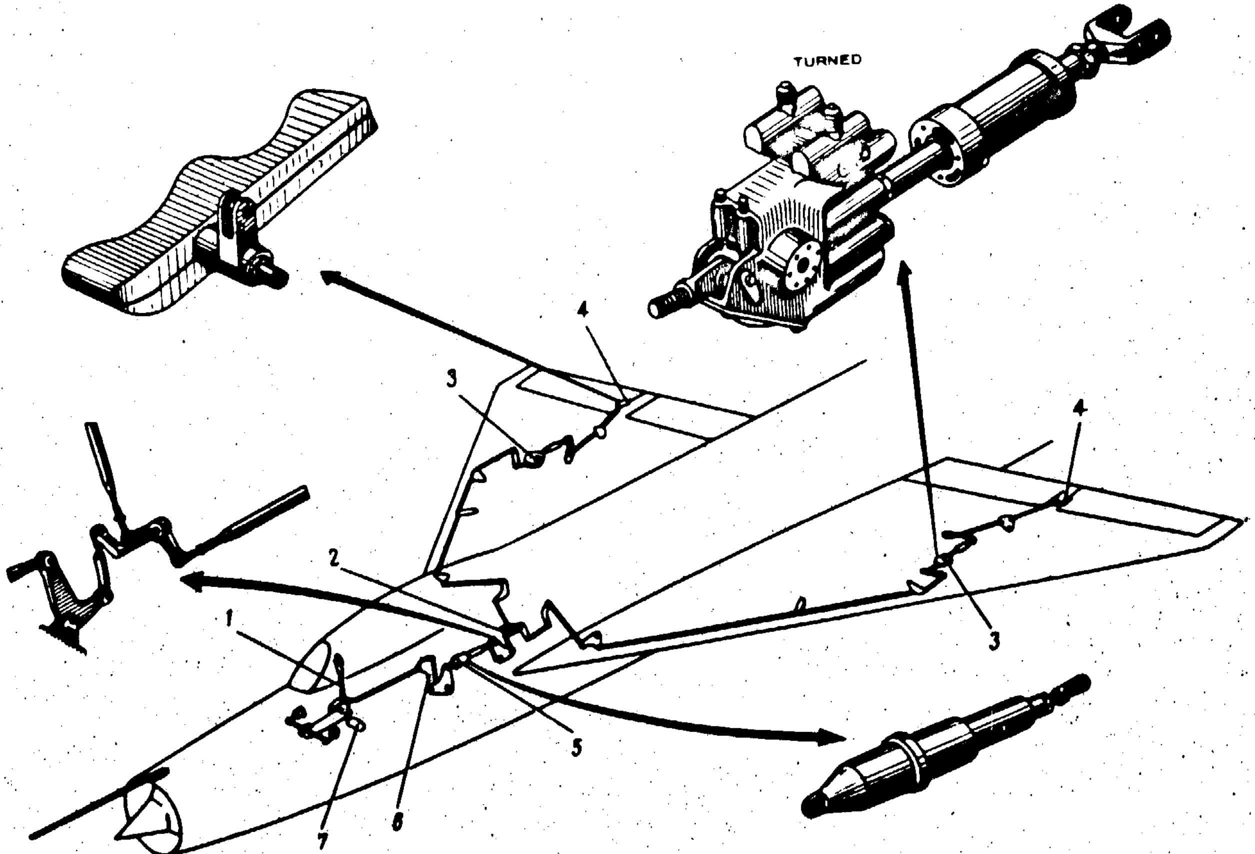

FIG.198. AILERON CONTROL SYSTEM
1 – control stick; 2 – rod-to-wing outlet unit; 3 – БУ-45А booster; 4 – aileron attachment unit; 5 – servo unit; 6 – transmission ratio non-linear change mechanism; 7 – artificial feel mechanism.

system. In case the pressure in the booster hydraulic system rises to half the value of the pressure maintained in the main hydraulic system, the latter is automatically cut off and the boosters are re-set for control to the booster hydraulic system as a result.

In case the БУ-45А boosters are disengaged (or both hydraulic systems fail in operation), the hydraulic boosters function as rigid links of the aileron control system.

From the side of the slide valve, the actuating rod of the hydraulic booster is connected to the control rods which run to the control stick; the other end of the rod is connected to the control rods running to the aileron. When the aircraft control stick is deflected to the right or to the left, the slide valve of each hydraulic booster is moved by the pilot; the slide valve operated in this manner, the actuating rod of one of the boosters is released to deflect the aileron up, while the actuating rod of the other aileron is pulled in to deflect the aileron down.

The hydraulic booster. type БУ-45А, operates hydromechanically and is provided with a follow-up control system.

Spring Artificial Feel Mechanism

The spring artificial feel mechanism (Fig.199) is intended to simulate aerodynamic pressures on the aircraft control stick by way of varying the stick loading, depending on the angles of aileron deflection.

The mechanism incorporates the following main parts: cylindrical cone 8 with eyebolt 12, rod 3 with eyebolt 1 freely mounting two sleeves 4 and 10, bushing 6 with washer 9, and two springs (one shorter spring 5 and one longer spring 7), and union nut 2. The cylindrical casing has an oil-seal unit.

The artificial feel mechanism is installed in the pilot's cockpit, below and to the left of the control stick.

The mechanism casing is attached to the cockpit floor, while the rod is secured to the aileron control lever. When the control stick is being deflected, the lever turns to pull or push rod 3. During the rod travel of up to 2.5 mm it is the shorter spring that is compressed and during the rod travel of more than 2.5 mm, the longer spring is compressed. The greater the amount of the control stick deflection, the heavier the spring compression and the stronger the pressure applied to the control stick.

Transmission Ratio Non-Linear Change Mechanism

The transmission ratio non-linear change mechanism (Fig.200) is installed in the cockpit under the seat. The body of the non-linear change mechanism is attached to the cockpit floor.

The transmission ratio non-linear change mechanism ensures small aileron deflection about its neutral position in response to large travels of the control stick. By the end of the travel of the control stick, the non-linearity of the transmission ratio is changed to eventually approach linearity once the stick is set in its final positions. Due to this, the mechanism provides a proper "feel" in the aircraft transversal controllability, with the БУ-45А boosters engaged, and ensures a comparatively easier control when the control stick is deflected through 1/3rd of its application range from neutral, with the hydraulic boosters disengaged.

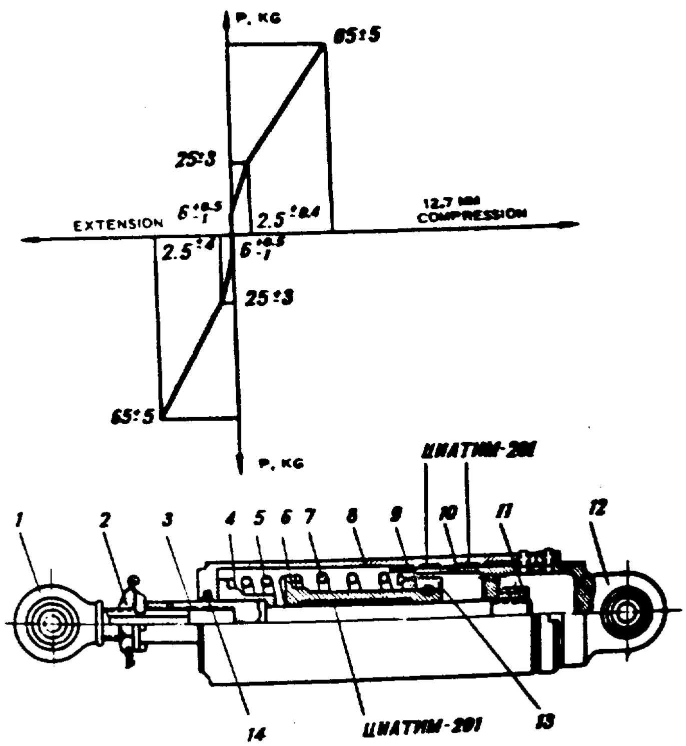

FIG.199. ARTIFICIAL FEEL MECHANISM OF AILERON CONTROL SYSTEM
1 – eyebolt; 2 – nut; 3 – rod; 4 – sleeve; 5 – spring; 6 – bushing; 7 – spring; 8 – body;
9 – washer; 10 – sleeve; 11 – nut; 12 – eyebolt.

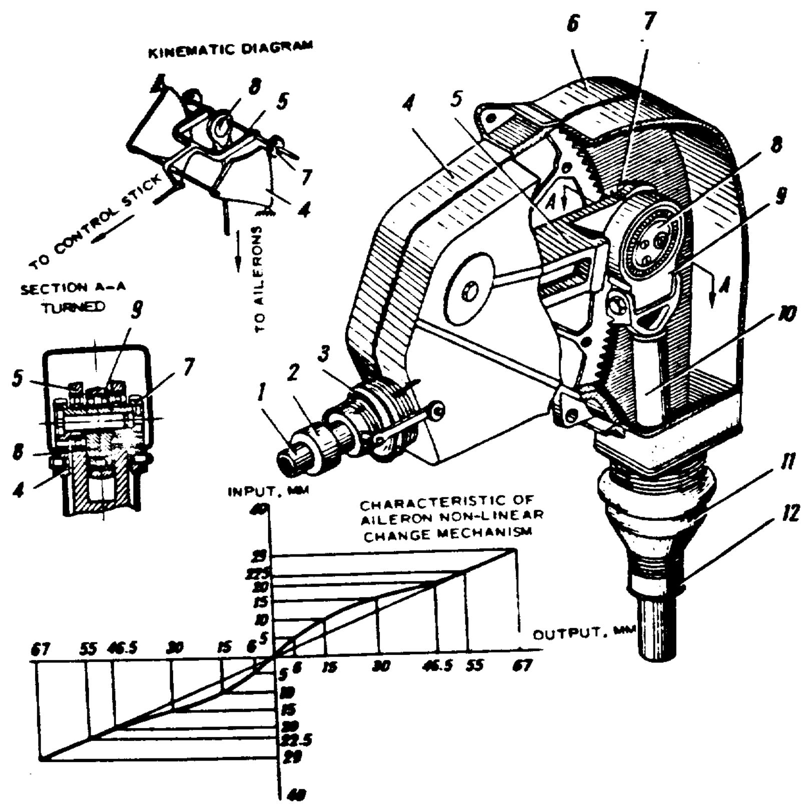

FIG.200. TRANSMISSION RATIO NON-LINEAR CHANGE MECHANISM
1 – aircraft control stick rod; 2 – bushing with gland; 3 – sealing jacket; 4 – bracket with toothed sector; 5 – bell-crank; 6 – casing; 7 – gear; 8 – eccentric; 9 – eyebolt; 10 – aileron control rod; 11 – sealing jacket; 12 – bushing with gland.

The transmission ratio non-linear change mechanism consists of welded bracket 4, having two geared sectors, casing 6, bell-crank 5, two gears 7, eccentric 8, eyebolt 9, two sealing units 3 and 11, and attachment units.

Bell-crank 5 is mounted in body 4. Attached to the top lever of bell-crank 5 is control rod 1 which is coupled with the control stick through a set of control rods and bell-cranks. Pressed inside the eyebolt of the lower bell-crank lever are ball bearings with the shanks of gears fitted therein. Gears 7 are locked in the teeth of the geared sectors of body 4 and provided with two-step shanks which permit the gears to be linked with bell-crank 5 and eccentric 8.

Fitted over eccentric 8 is eyebolt 9 which is bolted to the fork of control rod 10 attached to the ailerons.

Since the transmission ratio non-linear change mechanism is installed in the cockpit, it is provided with sealing jackets 3 and 11 used to protect the mechanism body against dust and foreign objects.

For more details pertaining to the description of sealing units, see the present Chapter, Section "Sealing of Control Units".

The application of the control stick drives bell-crank 5 of the transmission ratio non-linear change mechanism through a set of control rods and bell-cranks including control rod 1.

When bell-crank 5 is moved, gears 7 are set in motion which roll over the body sectors, cause the eccentric to turn and move control rod 10 coupled to the eccentric. Due to the fact that the gear axle rotates and moves in the direction of the movement of control rod 10, the eccentric body rotates, too, and makes eyebolt 4 move in the direction opposite to that of the movement of control rod 10.

This is the very cause of a restricted movement of control rod 10, i.e. of the non-linearity in the aileron transmission ratio. The non-linearity law characteristic of the mechanism operation is presented in Fig.200.

3. Automatic Pilot, Type КАП-2

Purpose

The aileron control system is fitted with an autopilot, type КАП-2, which is designed to improve the aircraft roll stability and controllability behaviour.

The autopilot operates in two duties:

1. Roll damping during manual control of the aircraft.
2. Stabilization during the automatic bringing of the aircraft to zero roll angle, zero roll angle stabilization and roll angle control in response to the control stick application.

The functions performed by the autopilot are as follows:

(a) aircraft roll damping in combination with the aircraft manual control (damping duty);

(b) automatic bringing of the aircraft to zero roll angle from any other initial roll angle (including the inverted flight) when the aircraft control stick is set at neutral in roll (stabilization duty);

(c) zero roll angle stabilization, with the control stick set at neutral in roll (stabilization duty);

(d) control of the aircraft roll angle within the range of $\pm 35^\circ$ in response to the control stick application within 50-70 mm from its neutral position in roll to the left and to the right (stabilization duty).

Units and Assemblies of КАП-2 Autopilot

The automatic pilot incorporates the following units and assemblies:

1. Servo unit РАУ-107.
2. Relay and amplifier unit РУБ-1ЗМ.
3. Roll rate gyro ДУС-К.
4. Transmission ratio corrector КПЧ-2.
5. Interference filter ФП-110.
6. Relay box КР-1А.
7. Phase-sensitive rectifier СЧВ.

To operate the autopilot, use is also made of a transmitting gyro of the artificial horizon type АГД-1.

Servo unit РАУ-107 (Fig.201) serves to convert the electric signals generated by the relay and amplifier unit into the mechanical motion of the actuating rod which through a system of rigid control rods and bell-cranks deflects the aileron at an angle proportional to the magnitude of the control signal, by aid of the БУ-45А hydraulic boosters.

The servo unit is essentially an extendable screw-type rod; it is installed behind the transmission ratio non-linear change mechanism under the cockpit floor in the aileron control circuit. There is a removable panel down on the fuselage to give access to the servo unit.

The servo unit consists of the following components:

(a) electric motor;
(b) transmission gear;
(c) electrical control system.

The outlet rod of the servo unit is set in motion by D.C. motor 1, type Д-25-1, 25 W, at 6,000 ±600 r.p.m.

The purpose of the servo unit transmission gear is to convert the rotary motion of the electric motor armature into the translational movement of the rod. The transmission gear comprises a double-reduction gear whose transmission ratio is i=2.5, and a screw pair.

The reduction gear includes driving pinion 3 secured on the shaft of the disc of limiting moment coupling 2 with a sliding fit, driven pinion 4, and pair of gears 6.

The outlet pinion of the reduction gear is spline-secured on the shaft of motion screw 23 having a trapezoidal single thread. The threaded part of the motion screw is locked with a threaded bushing fixed in rod 12. During servo unit operation the rod axle is centred in special supports.

Support 7 located near the rod end is a set of three ball bearings mounted in the body brackets on eccentric axles inclined at an angle of 120° to each other so that, when in motion, the rod slides along the outer bearing races.

The other support (section Б-Б) has a bracket which carries two bearings instead of a single bearing mounted on an eccentric axle. The two bearings rest with their outer races against a flat on the rod, due to which arrangement the rod is retained from turning when the motion screw is turned and the translational movement of the rod is ensured.

Motion screw 23 is directed in its movement by radial thrust bearings installed in the servo unit body. They retain the motion screw from axial displacement.

To restrict the maximum travel of the rod, a provision is made in the construction of the servo unit for special jam-free mechanical retainers which consist of two cams 5, one of which is made integral with the set of pinions 4 and 6, the other being made integral with the pinion fitted on the shaft of motion screw 23.

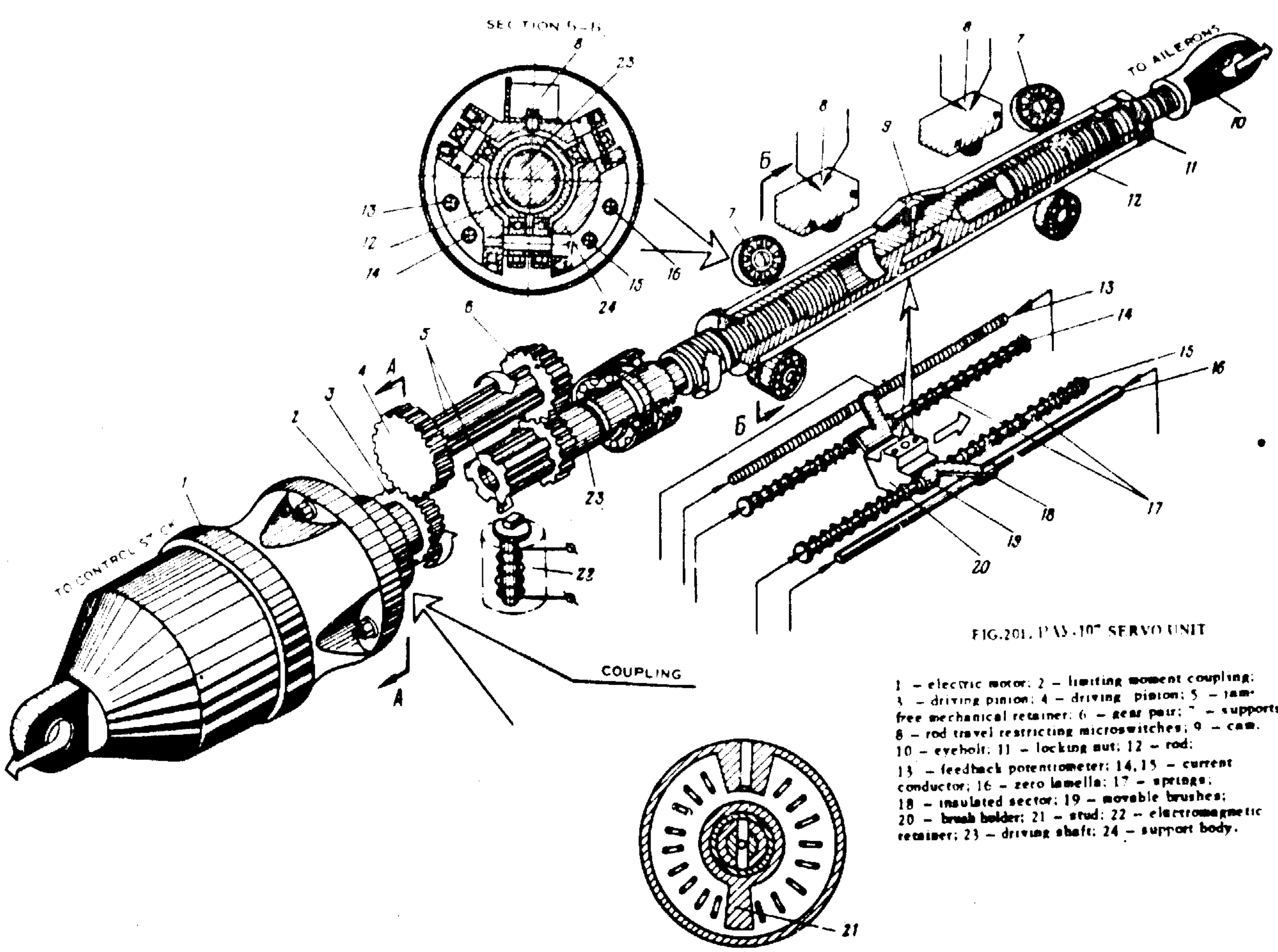

FIG.201. PAS-10? SERVO UNIT

1 – electric motor; 2 – limiting moment coupling; 3 – driving pinion; 4 – driving pinion; 5 – jam-free mechanical retainer; 6 – gear pair; 7 – supports; 8 – rod travel restricting microswitches; 9 – cam. 10 – eyebolt; 11 – locking nut; 12 – rod; 13 – feedback potentiometer; 14,15 – current conductor; 16 – zero lamella; 17 – springs; 18 – insulated sector; 19 – movable brushes; 20 – brush holder; 21 – stud; 22 – electromagnetic retainer; 23 – driving shaft; 24 – support body.

The number of the teeth of pinions 4 and 6 as well as the size of cams 5 are designed to allow maximum travel of the rod from its centre position within ±18 mm, which corresponds to 12 turns of the motion screw.

The instant the retainer is operated, both the servo unit rod and the electric motor armature are abruptly stopped. However, since the link of the reduction gear is locked at this time, the self-braking component (screw pair) will not be jammed and, with a reversal in the polarity of current flowing through the armature winding, the electric motor will be able to remove the servo unit mechanism from the retainer.

To protect the electric motor shaft from excessive stresses and strains due to abrupt stops of the rod when the mechanical retainer operates, the connection of the electric motor shaft with the transmission gear is effected through flexible coupling 2.

The flexible coupling consists of a driving disc with a tooth, the disc being secured on the motor shaft, and a disc with a collar spline-fitted on the shaft of pinion 3 of the reduction gear. There are pre-compressed springs inserted between the tooth and collar of the discs.

The torque is transmitted from the electric motor shaft to driving pinion 3 by virtue of compressing the springs inserted between the tooth of the driving disc and the collar of the disc fitted on the shaft of pinion 3.

Due to the impact between the cams of the mechanical retainer, the pinions of the reduction gear are abruptly stopped.

Acted upon by the inertia moment of the electric motor armature, the springs of the flexible coupling are compressed and the motor shaft is turned. After the motor is stopped, the motor shaft assumes a neutral position under the action of the spring. At the same time, delay in the impacts protects the motor shaft from residual strains.

The servo unit electrical control system consists of feedback potentiometer 13 and lamella 16 used to bring the rod in the mid-position when the damping and stabilization duties are cut off. The current is taken off from the potentiometer brushes by means of slip rings 14 and 15 made in the form of cylindrical springs, with guiding pins inserted in them. The ends of the springs are soldered to the pins. The slip ring keeps contact with brush 19 and is soldered to the middle of the springs. With the rod in the mid-position, the brush slides over insulated sector 18.

The travel of the servo unit rod in the autopilot circuit is restricted by limit switches 8. When acted upon by cam 9 fastened on the rod, the limit switch is actuated and the winding of the respective relay becomes de-energised. The armature winding of the electric motor gets shorted and the electric motor stops.

To lock the servo unit rod reliably, as soon as the damper is de-energised, the servo unit includes special electromagnetic retainer 22 consisting of electromagnet winding, armature with a tooth, and a retracting spring.

Once the electromagnet wiring is de-energized, the armature is moved forward due to the action of the spring, the tooth engages the slot of the unit of retainer 5, and keeps the screw from turning due to a dynamic unbraking of the screw pair as a result of vibration.

The sleeve of electric motor 1 is secured to the body of the reduction gear by four screws with nuts.

The connection of the servo unit circuit to the automatic pilot circuit is made by means of a bunched conductor passed through a rubber pipe.

Relay and amplifier unit РУБ-1КМ is intended to:

(a) sum up and amplify control signals generated by the roll rate gyro, phase-sensitive rectifier, rigid feedback and correction circuits (of the flexible feedback) and apply the amplified control signal to the actuating electric motor of servo unit РАУ-107;

(b) adjust the transmission ratios of the autopilot;

(c) suppress radio interference caused by the operation of the autopilot;

(d) commutate all electrical circuits of the autopilot.

The relay and amplifier unit is mounted between frames Nos 7 and 8, below, to the right in the direction of flight (in the storage battery compartment).

Roll rate gyro ДУС-К serves to measure the roll rate of the aircraft relative to the longitudinal axis and convert it into electrical signals proportional to the roll rate to be measured. The gyro is installed between frames Nos 7 and 8, below, to the left in the flight direction.

Transmission ratio corrector КПЧ-2 is intended to automatically change the autopilot transmission ratio in response to the roll rate signal, depending on the gas pressure and flying altitude values.

The transmission ratio correctors are located on automatic transmission ratio controller АРУ-3В to the left in the flight direction. The potentiometer brushes are connected to the rod of controller АРУ-3В and move together with the latter relative to the body of corrector КПЧ-1.

Interference filter ФП-110 is intended to suppress high-frequency interference caused due to the autopilot operation in the D.C. circuit.

The filter is installed between frames Nos 8 and 9, below, to the right in the flight direction.

Relay box КР-1А is used to commutate control signals and mounted between frames Nos 7 and 8, below, to the left in the flight direction, close to roll rate gyro ДУС-К.

Phase-sensitive rectifier ФЧВ is purposed to convert three-phase A.C. signals from the selsyn transmitter of the АГД-1 transmitting gyro into D.C. signals in response to roll in the range of 360°.

The rectifier is installed in the cockpit behind the instrument panel, to the left.

The АГД-1 transmitting gyro, from which roll angle signals are taken off is mounted in the upper equipment compartment between frames Nos 5 and 6.

Autopilot Operation

The interaction of the autopilot units is presented in Fig.202.

The rod moved as far as it will go, servo unit РАУ-107 deflects the ailerons transversally through ±5.5°, with the aircraft control stick set at neutral.

The aileron deflection by virtue of the control stick amounts to ±20° when the servo unit rod is set in the neutral position.

Thus, when operating the autopilot, it is only 27.5 per cent of the aileron complete deflection that is utilized. This is done to ensure the safety of flight with the autopilot used.

In case the servo unit rod shifts by itself all the way to the stop, the pilot can counteract the resulting roll by shifting the aircraft control stick in the opposite direction, approximately one third of its travel length.

When being operated for damping the autopilot diminishes the transversal oscillations of the aircraft at a sustained angle of roll or at the transition

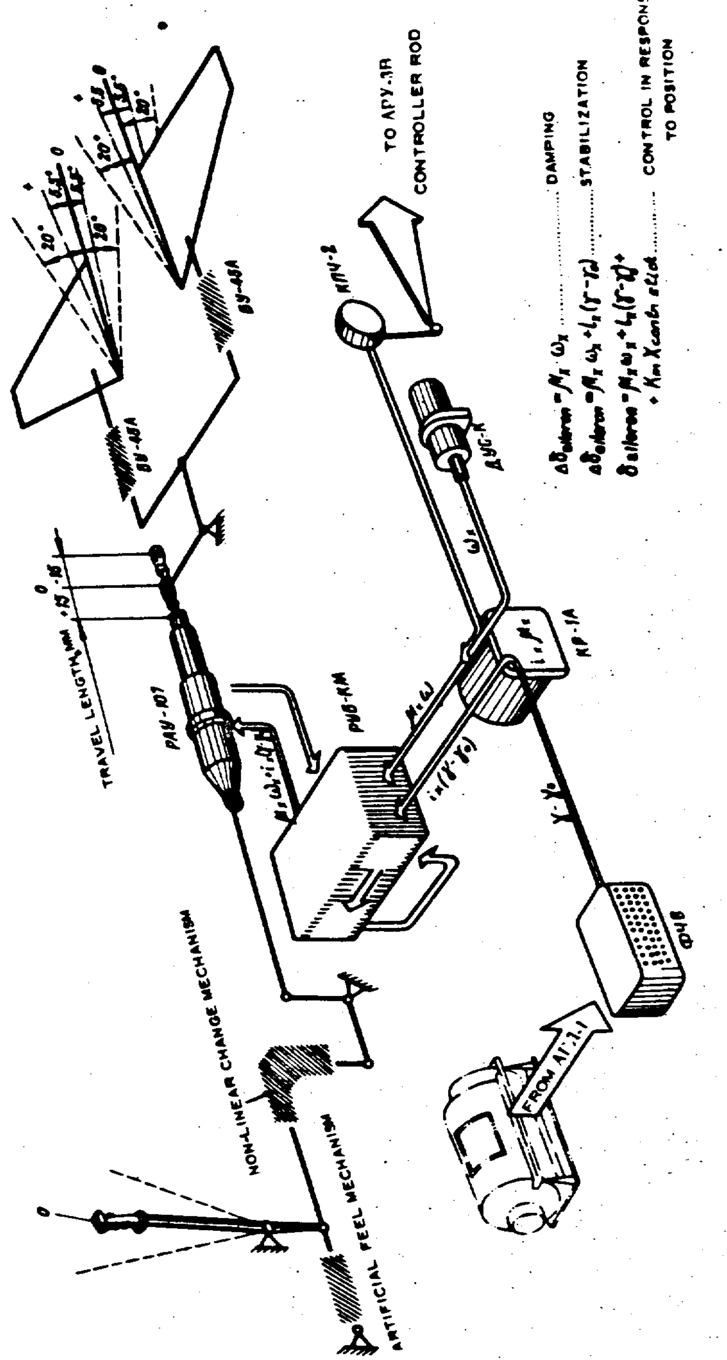

FIG. 202. AUTOPILOT КАП-2 OPERATING PRINCIPLE

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... one roll angle to another in response to the aircraft rate of roll ω_x. In ...ping, the aircraft piloting by means of the control stick is appreciably ...ilitated since the number of control stick applications required to control ... roll is reduced.

When being operated for damping, the autopilot deflects the ailerons (regard-...ss of the control stick application) according to the following law:

$$\delta_{aileron} = \mu_x \cdot \omega_x,$$

where

μ_x is the transmission ratio;
ω_x is the aircraft rate of roll.

When operating the autopilot for damping at the roll rate ω_x, the damping gyroscope and the transmission ratio corrector transmit signals to the relay and amplifier unit which generates voltage for the servo unit. The servo unit rod ...es out or in and deflects the ailerons by the value of $\mu_x \cdot \omega_x$ according to the above law. At the same time, there will be created a moment to oppose the roll rate ω_x.

Thus, the control stick application causes a reverse response on the part of the autopilot and the ailerons are deflected at a smaller angle. In this connection, the application of the aircraft control stick will reduce the roll sensitivity of the aircraft.

When being operated for stabilization, the autopilot (with the control stick set at neutral in roll) ensures:

(a) roll-free flight of the aircraft, with no pilot's action required;

(b) bringing the aircraft to zero roll angle from any position;

(c) piloting of the aircraft in roll in response to the control stick application.

When operated for stabilization, the autopilot obeys the following fundamental control law:

$$\delta_{aileron} = \mu_x \cdot \omega_x + i_x (\gamma - \gamma_0),$$

where

$\mu_x \cdot \omega_x$ is the law of damping;
i_x is the positional transmission ratio;
γ is the aircraft present roll angle;
γ_0 is the aircraft zero roll angle.

The implementation of the above-stated control law allows the aircraft to be kept in a no-roll altitude with an accuracy of $\pm 1.5^\circ$.

The signal of the present roll angle γ is linearly generated by the АГД-1 transmitting gyro (the signal magnitude being proportional to the roll value) within the range of roll angles up to $\pm 35^\circ$. In case roll angles exceed 35°, the roll angle signal retains a constant value and sign till the angle of 145° is reached ($180^\circ - 35^\circ$), after which the signal value is again decreased in a linear manner to the 180° angle of roll. When the latter angle is passed, the signal sign is reversed, while the signal value increases and becomes maximum at a roll angle of $180^\circ + 35^\circ$. Further on, both the value and sign are kept constant till the roll angle of $360^\circ - 35^\circ$ is reached.

The polarity (sign) of the roll angle signal is also reversed in case the aircraft passes a pitch angle of 90°. Thus, once the roll angle signal is picked off from the transmitting gyro, it becomes possible to bring the aircraft to zero roll angle from any initial roll angle (including the case when the aircraft performs an inverted flight and when pitch angles are large and range from 70° to 80°).

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In case the autopilot is operated for stabilization and the aircraft is piloted in response to the control stick application (when the control stick is transversally applied to travel 50-70 mm), the following fundamental control law is observed:

$$\delta_{aileron} = \mu_x \cdot \omega_x + i_x\ (\gamma-\gamma_0) + K_n \cdot X_{contr.\ stick},$$

where

$\mu_x \cdot \omega_x + i_x\ (\gamma-\gamma_0)$ is the law of stabilization;

K_n is the control stick-to-aileron transmission ratio;

$X_{contr.\ stick}$ is the linear transversal application of the control stick.

When applying the aircraft control stick transversally by ±50-70 mm, with the autopilot operated for stabilization, the pilot can alter the roll angle within the range of ±35°, piloting the aircraft in response to the control stick application.

In case the aircraft control stick is transversally moved by more than 50-70 mm, the aircraft will be piloted in an ordinary way in response to the angular rate, i.e. this time, there will be utilized a complete travel of the servo unit rod which will be operated as a common rigid control rod.

Autopilot Engagement and Control

The power supply for the autopilot is cut in by means of the АП and АГИ toggle switches located on the starboard immediately after the engine has been started. Simultaneously, gyro horizon АГИ-1 is set in operation and the gyroscope of roll rate gyro ДУС-К is actuated. As soon as the power supply is cut in for the autopilot, the signals generated by gyro horizon АГИ-1 and roll rate gyro ДУС-К do not reach the servo unit; as a result, the servo unit is kept at neutral, being but a rigid rod. If the servo unit is not kept at neutral before the power supply is switched on for the autopilot, it will automatically be set in the neutral position the moment the power supply is cut in.

The autopilot is switched on to operate for damping by means of the roll damping toggle switch mounted at port side and bearing the inscription ROLL DAMPER and NEUTRAL. The toggle switch should be set at ROLL DAMPER. In this case the servo unit gets unlocked, the signal $\mu_x \cdot \omega_x$ reaching the unit from the damping gyroscope. The servo unit starts operating as an extendible rod to deflect the ailerons (in response to the aircraft roll rate), thus counteracting the aircraft roll deviations.

Deviations in the damping duty are introduced by the same toggle switch when it is shifted from position ROLL DAMPER to the position NEUTRAL. In this case, the servo unit rod is automatically brought in the neutral position and the servo unit starts to operate as a rigid rod.

The autopilot is engaged for stabilization by a button provided on the handle of the control stick. The engagement of the autopilot for stabilization is indicated by signal light AUTOPILOT ON located on a white line marked on the instrument panel. When ON for stabilization the autopilot is also automatically engaged for damping, if it has not been engaged for it before. As a result, the servo unit is reached by a signal from the damping gyroscope and gyro horizon.

The autopilot is disengaged from operating for stabilization by means of the second (red) button mounted on the control stick handle. In this case the damping duty remains engaged, provided it has been engaged before by means of the toggle switch set in position ROLL DAMPER.

In the stabilization duty the roll angle is altered by shifting the control stick transversally.

At this instant, once the control stick moves ±50–70 mm, the piloting is effected in response to the control stick application, i.e. every position of the control stick is accompanied by a certain respective roll angle (not in excess of 35°) maintained by the autopilot. The shifting of control stick by more than ±70 mm will result in an ordinary piloting of the aircraft in response to its roll, i.e. the roll required (in excess of 35°) will have to be maintained by use of the control stick.

In order to bring the aircraft to zero roll angle, the pilot should return the control stick to the neutral position, taking as a guide the white line and the signal light on the instrument panel.

Chapter VII

VENTILATION, PRESSURIZATION AND AIR TEMPERATURE REGULATION

1. General

The pilot's cockpit is a sealed, ventilated cabin provided with an automatic temperature regulation system.

The cockpit is supplied with air from the engine compressor via two manifolds, one of which runs along the profile of the canopy movable section and the other is passed in the cockpit front lower part and is intended to supply air to the pilot's feet.

The connection between the manifold of the canopy movable section and the air mains is of a quick-release type to ensure a ready separation of the canopy in case of emergency jettisoning.

The cockpit sealing is ensured by the surface sealing paste, grade У-30М, as well as by sealing the lead-outs of control rods, the cabling system, electric wirings, and piping. The canopy movable section is sealed by a rubber sealing hose inflated with compressed air fed from the aircraft main air system.

The units incorporated in the cockpit ventilation, pressurization and air temperature regulation system are presented in Fig.203.

To ventilate the cockpit on the ground, special branch pipe 19 is provided to which a hose from the special ground installation, type [illegible]-1, is connected.

Prior to the flight, the branch pipe is to be closed with a special plug.

There is a fan, type ДВ-3, installed in the cockpit. The fan is mounted above the right-hand electric board of the instrument panel and is screwed to the electric board casing. The fan is to be installed in hot weather; in other seasons, it is kept in storage in a single set of the aircraft spare parts, tools and accessories.

The hot-air pipelines are coated with a varnish, heat-insulated with a layer of АСИМ-5 heat-insulating material and wrapped with a tape State Standard ГОСТ 5937-56. The pipelines are secured to the aircraft structure by clamps.

In order to ensure normal operation of the aircraft radar transceiver unit, an additional pressurization is provided with air supplied from the engine compressor. The pressurization pipeline is connected to the air mains used to furnish air for the anti-g suit.

2. System Operating Principle

The system incorporates three air supply mains to feed the cockpit with hot, cold or mixed air.

All the three mains are fed with air from the engine compressor through air distributing valve 11 (unit 525).

The valve is remotely controlled with the aid of an air temperature regulator, type ТРТБК-45М, and by means of a ПЗПН-20 change-over switch having four positions: HOT, COLD, AUTOMATIC and NEUTRAL. The change-over switch is mounted on the vertical part of the left-hand console.

With the switch set in the HOT position, the air distributing valve supplies air from the engine compressor directly to the cockpit by-passing the cooling devices.

When the switch is set in the COLD position, the air distributing valve supplies the cockpit with air preliminarily cooled in air cooler 4 and turbocooler 12.

With the change-over switch in the AUTOMATIC position, the cockpit is fed with mixed air in the required proportion.

Some of the air supplied from the engine compressor is delivered directly into the cockpit air mains, while the remaining part is directed to the same mains through air cooler 4 and turbocooler 12. The air temperature is automatically maintained by ТРТБК-45М air temperature regulator 8 within preset value indicated on the scale.

The air supply system control is cut off when the switch is positioned at NEUTRAL.

The delivery of hot, cold or mixed air into the cockpit is ensured by air supply valve 14 which has two positions: OPEN and CLOSED.

The valve has a cable remote control system provided with a control handle installed in the cockpit on the right-hand console. It is opened prior to the engine starting and set in the CLOSED position when on the ground.

In case smoke, vapours of kerosene and engine oil get into the cockpit, the cockpit air supply is cut off from the engine by setting the valve control handle in the CLOSED position.

The pressure in the cockpit is maintained by the АРД-57В automatic pressure regulator which provides cockpit ventilation at an altitude ranging from 0 to 2000 m. With a maximum air consumption of 550 kg/hr, the excessive pressure at the above altitude does not exceed 30 mm of mercury. At altitudes from 2000 to 9000 - 12,000 m., the excessive pressure gradually rises and reaches the value of 220 $\pm$10 mm of mercury. The cockpit excessive pressure is kept constant at a value of 220 $\pm$10 mm Hg at altitudes above 9000 - 12,000 m.

In case the automatic pressure regulator fails in operation, the excessive air is released through the ПК safety valve adjusted to an excessive pressure of 240_{-5} mm of mercury.

The pressure differential between the cockpit and the atmosphere as well as the cabin altitude are checked by the УВПД-20 altitude and pressure differential indicator.

3. Cockpit Air Supply System Units

АРД-57В Set (Fig.204)

The АРД-57В set comprises two units, namely: a control instrument (the 2013В pressure regulator), and an actuating mechanism (the 520Б pressure regulator servovalve). These units are installed in the cockpit separately and interconnected by means of a special pipe.

The air consumption in the sealed cockpit is ensured by the 520Б pressure regulator valve.

With a preset volume of air consumption, the valve is automatically kept open to such an extent so as to ensure a constant pressure in the cockpit, depending on the flight altitude.

Valve 4 is opened up to an altitude of 2000 m.; in this case cavities А, Б, Г and Д communicate with the atmosphere and, correspondingly, the cockpit pressure approximates the atmospheric pressure (to be more exact, the cockpit pressure will exceed the atmospheric pressure by the value of the resilience of spring 17 related to the effective surface area of diaphragm 12).

If this is the case, valve 20 opens under an inconsiderable pressure from the cockpit upon diaphragm 12. To open the valve, the cockpit pressure has to overcome the tension of spring 17.

Orifice 11 is intended to decrease the volume of air consumed in the control instrument and improve the reliability of its action. The climbing speeds being preset, the rate of change in the cockpit pressure can be regulated by a proper selection of the orifice diameter.

When climbing, the atmospheric pressure decreases and the effort acting upon sylphon 1 lessens, thus causing an expansion of the sylphon and a gradual closure of valve 4.

At an altitude of 2000 m., sylphon 1 expands to such an extent that valve 4 shall completely close orifice 18, and the absolute pressure will then be adjusted in the following way: the instant valve 4 closes, the pressure in cavity А begins to increase due to the delivery of air into the cockpit, with the 520Б outlet valve closed. This pressure will act on diaphragm 3 and sylphon 1. Due to the pressure difference in cavities А and Е, the sylphon will contract and again open valve 4, releasing thereby air from cavity А into the atmosphere via tube 19. The pressure in cavity А and, hence, in cavity Д decreases.

Since the relation between pressures in cavities Д and Е is smaller, valve 20 opens and releases the cockpit air into the atmosphere until the required pressure is set up again.

The absolute pressure is regulated in this way up to an altitude of 9000–12,000 m.

With further climbing, commencing from 9000 to 12,000 m., when the excessive pressure reaches 220 $\pm$10 mm of mercury, the excessive pressure regulator begins to operate and valve 8 opens, since the effort created by the pressure difference and acting upon diaphragm 6 exceeds that of spring 7.

Thus, beginning with the above-mentioned altitudes, a constant pressure difference is maintained between cavity В and atmosphere.

This constant pressure differential between cavity В and the atmosphere ensures a constant value of excessive pressure in the sealed cockpit of the order to 220 $\pm$10 mm Hg.

In case the aircraft performs a sharp descending, the atmospheric air pressure may exceed the cockpit pressure. Then, diaphragm 12 of the 520Б valve will

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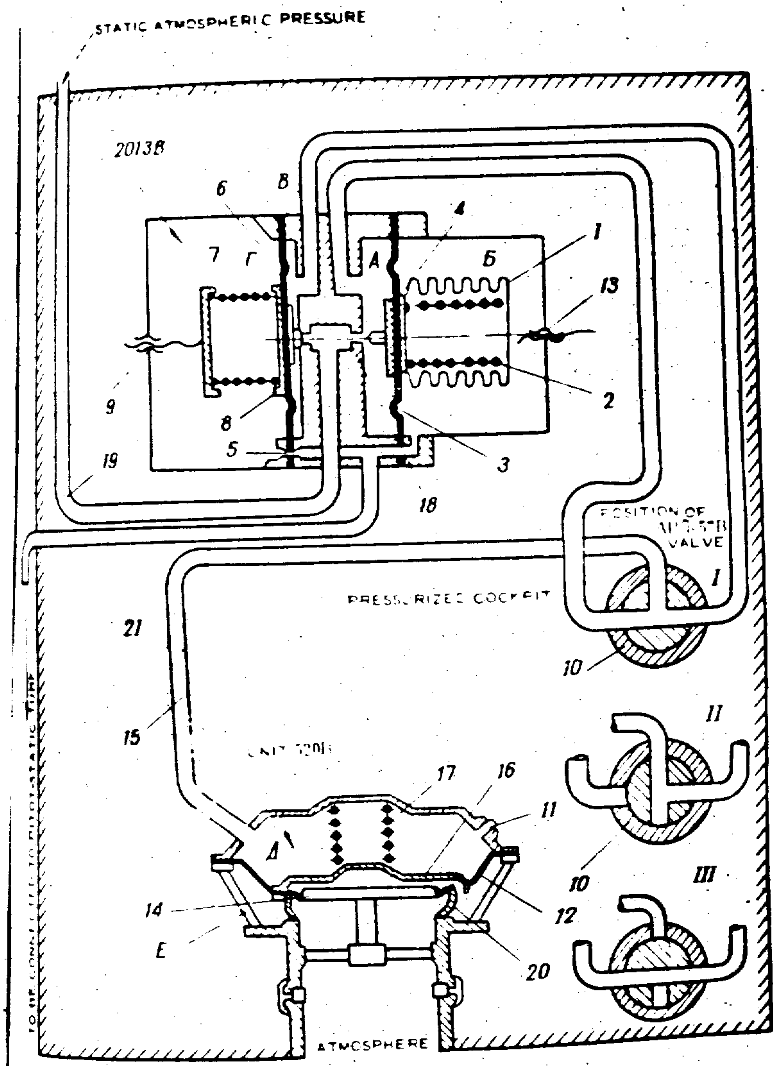

POSITIONS OF PRESSURE REGULATOR VALVE

I – ON POSITION: VALVE IS CUT IN FOR FLIGHT. FROM 0 TO 2 KM. – VENTILATION. FROM 2 TO 9-12 KM. – EXCESSIVE PRESSURE RISE UP TO 220±10 MM HG. FROM 9-12 KM. – CONSTANT EXCESSIVE PRESSURE OF 220±10 MM HG.

II – CHECK POSITION: VALVE IS CUT IN FOR COCKPIT GROUND OPERATION AT CONSTANT EXCESSIVE PRESSURE OF 220±10 MM HG.

III – OFF POSITION: VALVE IS CUT IN FOR CHECKING COCKPIT TIGHTNESS. COCKPIT AIR OUTLET DUCT IS CLOSED.

FIG. 204. APД-57B PRESSURE REGULATOR

1 – sylphon; 2 – spring; 3 – diaphragm; 4 – valve; 5 – capillary tube; 6 – diaphragm; 7 – spring; 8 – valve; 9 – screw; 10 – valve; 11 – orifice; 12 – diaphragm; 13 – screw; 14 – supporting disc; 15 – tube; 16 – valve disc bottom; 17 – spring; 18 – pressure regulator orifice; 19 – tube; 20 – valve; 21 – tube.

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be pressed to the disc bottom of valve 16; due to the action of the atmospheric pressure exceeding the cockpit pressure, the 520Б valve will open and let the atmospheric air in. Three-way valve 10 makes it possible to set the handle in the following three positions:

I - ON - for the normal operation of the pressure regulator;

II - CHECK - for checking the cockpit excessive pressure when on the ground;

III - OFF - for checking the cockpit sealing on the ground.

Valve position CHECK is not made use of on this aircraft.

Electric Air Distributing Valve (unit 525) (Fig.205)

The air distributing valve is designed to receive air from the engine compressor and supply it to the hot or cold air line or to both the lines simultaneously.

The air distributing valve is connected electrically with the TPTBK-45M air temperature regulator.

The air distributing valve has an electric remote control ensured by a change over switch with four positions: HOT, COLD, AUTOMATIC and NEUTRAL.

As regards its construction, the air distributing valve consists of two main parts: an electric mechanism and a distributing device.

The distributing device has four pipe connections: for hot air inlet and outlet, for cold air outlet and a vent connection to release air to the atmosphere so as to prevent hot air from leaking into the cold air line due to a higher pressure created in the hot air line than in the cold air line.

The air distribution is ensured with the aid of three by-pass shutters actuated from the electric mechanism through a linkage mechanism.

The linkage mechanism mounted on a special axle and on the pins of the shutters is connected by means of a fork with a guide of the electric mechanism which transmits rotary motion to the linkage mechanism.

When setting the required temperature on the scale of the TPTBK-45M air temperature regulator, its bimetallic spiral depending on the cockpit temperature closes the circuit contacts of the distributing valve electric motor; the latter begins to rotate and turns the valve shutters into such a position, at which the air delivered into the aircraft cockpit maintains the preset temperature in the cockpit.

The electric mechanism consists of five main parts: electric motor 5, reduction gear 6, potentiometer 7, limit switches 10 and 14, and electric filter 8.

Electric motor 5 is a 7 W, 27 V series, reversible motor with two excitation windings for direct and reverse running.

Reduction gear 6 is used to reduce the speed of rotation transmitted from the engine to the shutters. It consists of three pairs of tooth gears and two pairs of worm gears having a common transmission ratio of 1:20,000.

Potentiometer 7 is intended to ensure the feedback in the cockpit air temperature regulation system by virtue of altering the voltage magnitude depending on the turn of the reduction gear outlet shaft, thus changing the magnitude of a magnetic field induced on the feedback coil of the TPTBK-45M air temperature regulator. The potentiometer is mounted in the reduction gear casing. The potentiometer incorporates the following components: block 12 with a resistance winding, slide 11, cam 13, and limit switches 10 and 14.

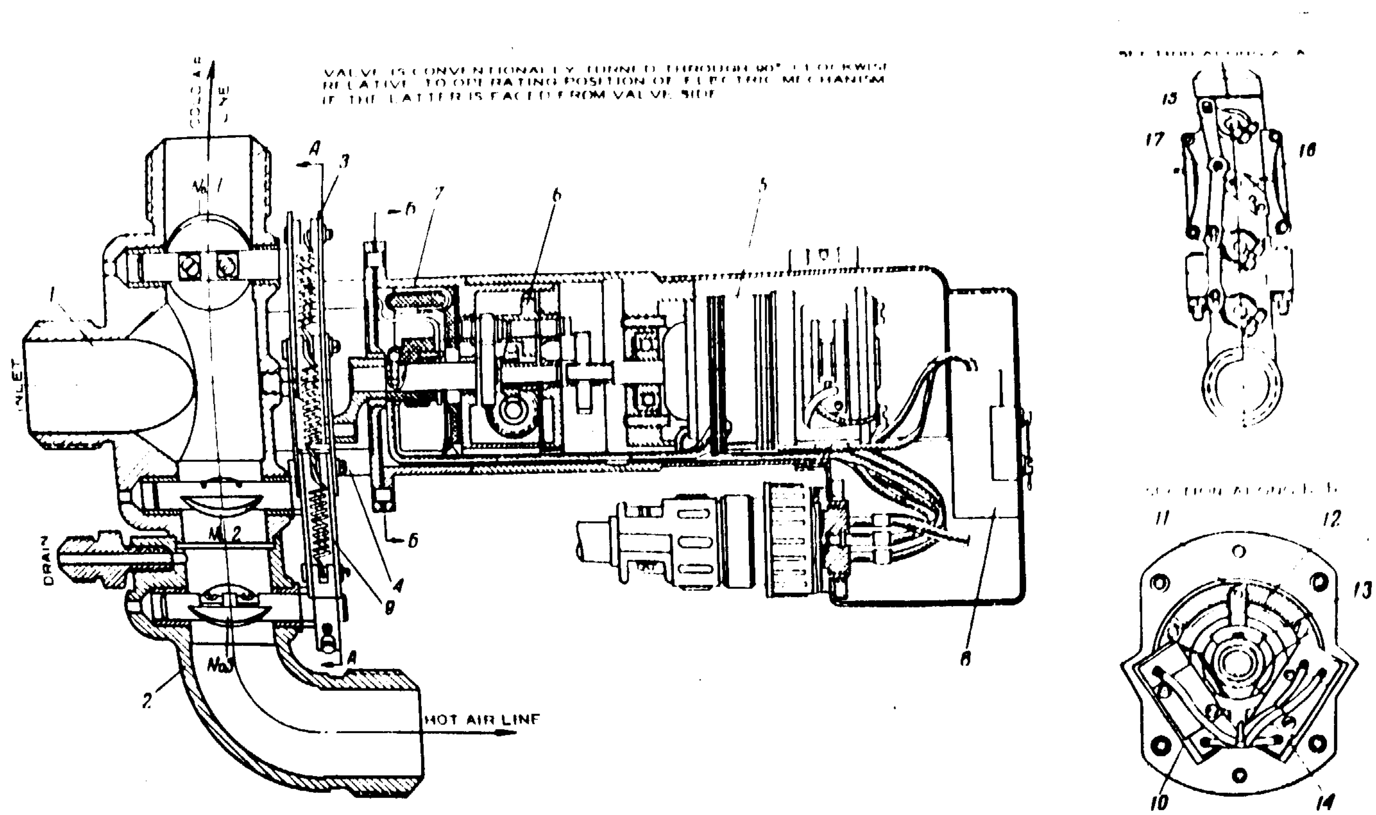

FIG.205. ELECTRIC AIR DISTRIBUTING VALVE (UNIT 525)

1 – distributing device body; 2 – detachable pipe connection; 3 – linkage mechanism; 4 – coupling screw; 5 – electric motor; 6 – reduction gear; 7 – potentiometer; 8 – electric filter; 9 – spring; 10, 14 – limit switches; 11 – slide; 12 – block with resistance wiring; 13 – cam; 15 – lever; 16 – guide; 17 – guide rotation axle.

The potentiometer resistance winding has two lead-outs connected through a plug connector to the inboard electric mains (Fig.206). A locking washer of slide 11 is electrically connected with the feedback coil of the air temperature regulator by means of a conductor.

Limit switches 10 and 14 serve to cut off the electric motor in case the shutters are set in their extreme positions. Limit switch 10 ensures the operation of the electric motor until the hot air line is completely cut off, while limit switch 14 does so until the cold air line is cut off.

When in the extreme positions, the circuit becomes broken and the electric motor is stopped as a result.

Electric filter 8 is used to reduce radio reception interference and includes several capacitors.

Fig. 206 presents a circuit diagram of the air distributing valve and temperature regulator.

The electric mechanism is supplied with direct current from the aircraft common 27 V, D.C. mains and is electrically actuated from either the TPTH-45E air temperature regulator or from the four-position change-over switch located in the pilot's cockpit.

Cam 13 (Fig.206), slide 11 and guide 16 can turn only within 90°. This travel is ensured by the interaction between cam 13 and limit switches 10 and 14. When in the extreme positions, cam 13 presses on the contacts of the limit switches and breaks the electric motor circuit.

With cam 13 set in one of the extreme positions, either the hot or cold air line is completely cut off, while the other one is completely open. In any of the intermediate positions, both the lines are partly opened.

If the intermediate position of cam 13 is to be taken as the initial one and an air temperature in the cockpit, to be equal to 12°C, the mechanism will operate in the following way: with an air temperature drop in the cockpit, the temperature regulator closes the electric circuit and sets in operation the electric motor and, hence, the electric mechanism as a whole. If the electric mechanism is faced from the side of the air distributing valve, cam 13 and slide 11 will rotate clockwise, thereby allowing the operation of the hot air line and shutting the cold air line.

If the cockpit air temperature has reached 12°C but guide 16 has not yet managed to cut in the hot air line completely, i.e. it has not yet reached its extreme position, the temperature regulator breaks the electric circuit and cuts off the electric mechanism pending a new air temperature change by a value beyond the sensitivity of the temperature regulator.

When guide 16 of the electric mechanism (Fig.206) has reached its extreme position, i.e. it has completely opened the hot air line and shut the cold air line, cam 13 aided by limit switch 10 will break the electric motor circuit and cut off the electric mechanism.

In the event of an air temperature rise in the cockpit, the temperature regulator also closes the electric circuit and actuates the electric mechanism.

If the electric mechanism is looked at from the side of the air distributing valve, cam 13 and slide 11 rotate counter-clockwise, thus opening the cold air line and shutting the hot air line.

In case the cockpit air temperature has attained 12°C and the guide has not yet reached its extreme position, i.e. it has failed yet to completely cut in the cold air line, the temperature regulator breaks the electric circuit until a new change occurs in the cockpit air temperature.

then guide 16 of the electric mechanism has reached its extreme position, it has completely opened the cold air line and shut the hot air line, cam 13 by limit switch 14 will break the electric circuit and cut off the electric anism. This being the case, it is only the cold air line that supplies air the aircraft cockpit.

Air Temperature Regulator (Fig.206)

The cockpit air temperature regulator, type ТРТВК-45М, is used to automatically maintain the air temperature in the cockpit within the preset value.

The dial provided on the temperature regulator permits to preset an air perature in the cockpit within a required range from 10° to 20°C. Normally, dial is set at +12°C.

The temperature regulator consists of bimetallic spiral 18, movable contact 19, two fixed contacts 20 and 21, feedback electromagnetic coil 22, a dial spark extinguisher 23.

The principle of the temperature regulator action consists in the following: bimetallic spiral is blown off with air by means of an ejector.

The air is supplied for the ejector from the cockpit air supply mains in nt of the air supply valve and delivered to the ejector through a 6x4 dia. If the cockpit air temperature exceeds 12°C, the bimetallic spiral extends, ses the movable and fixed contacts and cuts in the electric motor which turns shutters of the air distributing valve to supply cool air to the cockpit.

At temperatures below 12°C, the bimetallic spiral contracts, closes the vable and fixed contacts and cuts in the electric motor which turns the shutters of the air distributing valve to supply hot air to the cockpit.

The РП-2 relay unit is an intermediate link connecting the air temperature ulator and actuating electric mechanisms.

The relay unit is controlled by the temperature regulator contacts. In their n, the relay unit contacts are used to control the actuating mechanism, МРТ-1, by virtue of cutting in the respective excitation winding circuits of reverse electric motor which aided by the reduction gear moves and sets the tters of the heat exchangers in a certain position, depending on the sealed pit air temperature deviations from the preset value.

To reduce temperature fluctuations, the air temperature regulator has a dback electromagnetic coil connected to a potentiometer of the electric mechan. One of the potentiometer and feedback coil terminals is positive and the her potentiometer terminal is negative, the potentiometer slide being connected cross the other terminal of the feedback coil.

Turning together with the shutters of the air distributing valve to the ght and to the left, the potentiometer slide alters the voltage at the minals of the feedback coil.

The higher the voltage in the feedback electromagnetic coil, the higher the ltage at the movable contact. Being attracted to the feedback electromagnetic , the movable contact breaks the circuit and engages the electric motor not before the cockpit air temperature reaches 12°C. Such an advance is necessary because the bimetallic spiral does not at once attain the ambient temperature, i.e. the spiral possesses a certain inertia as regards the temperature sceptibility, which may result either in elevated or lowered temperatures in the cockpit.

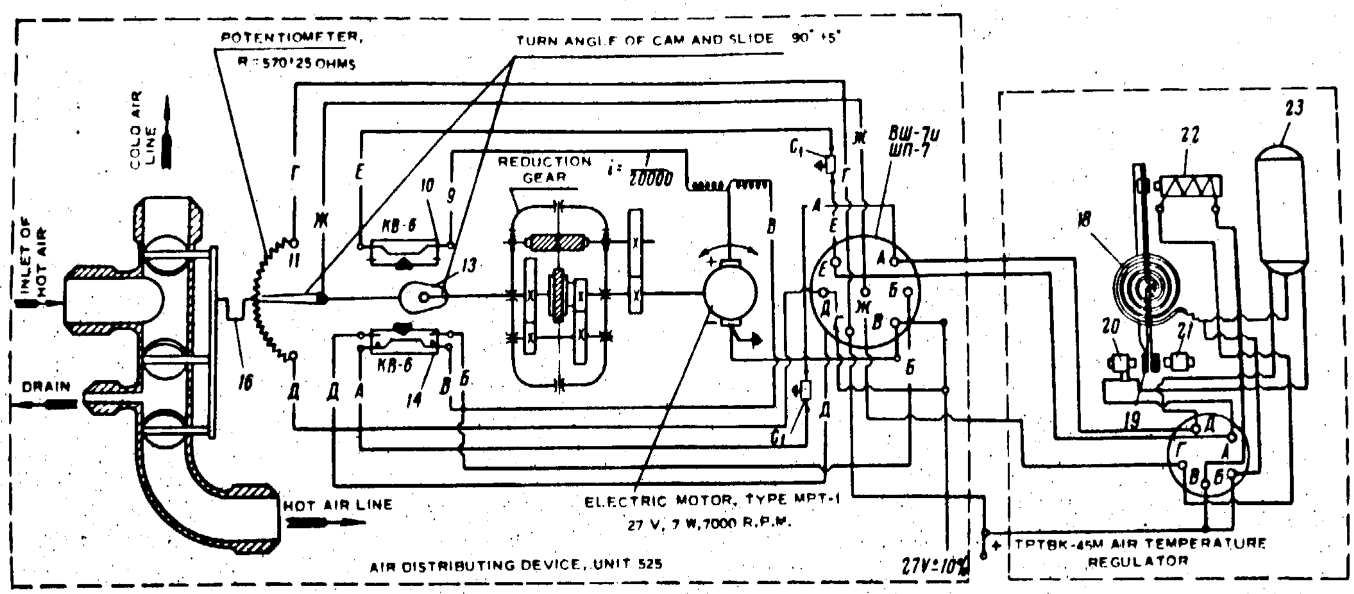

FIG.206. SCHEMATIC DIAGRAM OF AIR DISTRIBUTING DEVICE WITH TEMPERATURE REGULATOR
10, 14 – limit switches; 11 – slide; 13 – cam; 16 – guide; 18 – bimetallic spiral; 19 – movable contact; 20, 21 – fixed contacts; 22 – feedback electromagnetic coil; 23 – spark-extinguishing unit.

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[illegible] Safety Valve (Fig.207)

The valve is intended to prevent the cockpit from entire destruction due to pressure rise in excess of the permissible value. Once the cockpit excessive pressure reaches 240$_{-5}$ mm of mercury, it is relieved by the valve which opens up.

The valve consists of a body, disc-shaped plate with a rod, and a spring. The tension of the spring is adjusted by means of a washer and a nut screwed on the rod of the valve disc.

Air Cooler (Fig.208)

The purpose of the air cooler is to cool air before it is delivered to the turbocooler. It is a two-wall cylinder with a corrugated sheet secured inside by means of continuous welding.

From the air distributing valve, hot air enters the air cooler, passes between the air duct wall and the corrugated sheet and comes out into the turbocooler.

Hot air is chiefly cooled in the air cooler by the air which passes through the intake duct to the engine (it is the radiator interior wall that is cooled).

Besides, air is taken into the cooler from the engine intake duct through the cooler orifices. Upon entering the cooler, air flows along the corrugated sheet and goes out into the atmosphere through the branch connection. The cooling air is released into the atmosphere due to a pressure difference in the intake air duct.

The air cooler has an efficiency $\eta = 0.8$.

Turbocooler

The turbocooler, unit 2323, is the second stage in the air cooling system delivering air from the engine compressor into the aircraft pressurised cockpit. The turbocooler is installed in the cold air line after the air cooler.

The turbocooler consists of two major components: a turbine and a fan interconnected by a common shaft which is mounted on a pair of ball bearings.

Principally, the turbocooler operates as follows: the compressed air is delivered from the engine compressor to the turbine nozzles through the air cooler.

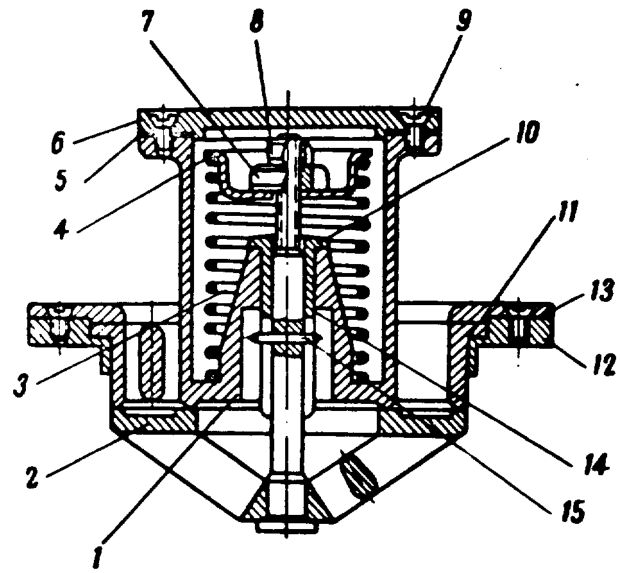
In the nozzles, the air potential energy is transformed into the kinetic energy. From the nozzles, the air gains a high speed and rushes on to the turbine blades, making the turbine and its rotor as a whole rotate. In this way, the air kinetic energy is converted into the mechanical work of the turbine.

The power developed by the turbine is taken off to rotate the fan which presents a sort of an air brake in the particular case.

The air is delivered to the fan guide vanes from the air intake duct and ejected back into the same duct.

Having actuated the turbine disc blades, the air loses 90 per cent of its initial speed obtained in the turbine nozzles and leaves the blades at a lower speed, pressure and temperature.

The cooled air is directed into the aircraft cockpit through an air outlet branch connection.



OPERATING DIAGRAM
(AT $P_{EXC} \geq 240_{-5}$ MM HG)

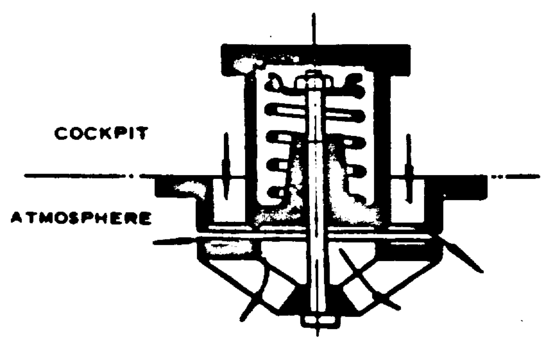


FIG.207. SAFETY VALVE
1 – body; 2 – valve; 3 – spring; 4 – washer; 5 – gasket;
6 – cover; 7 – nut; 8 – locknut; 9 – screw; 10 – bushing;
11 – gasket; 12 – flange; 13 – ring; 14 – rod; 15 – pin.

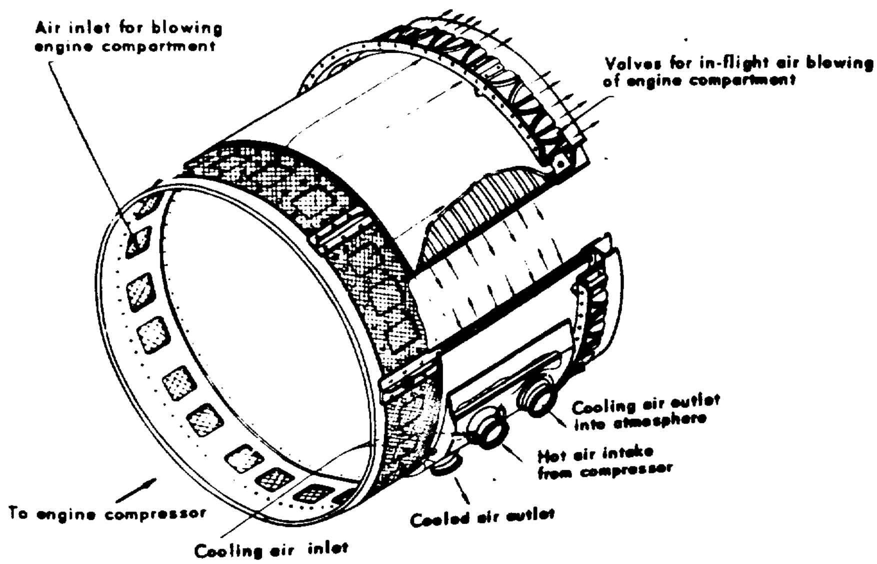


FIG.208. AIR COOLER

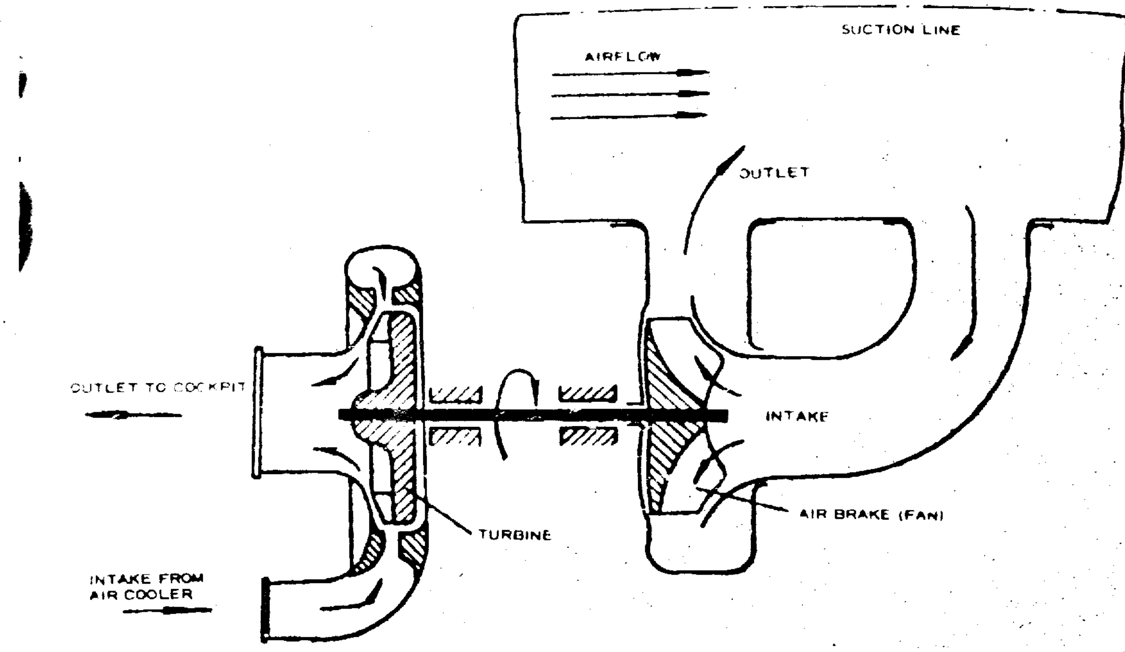


FIG.209. OPERATIONAL DIAGRAM OF TURBOCOOLER (UNIT 2323)

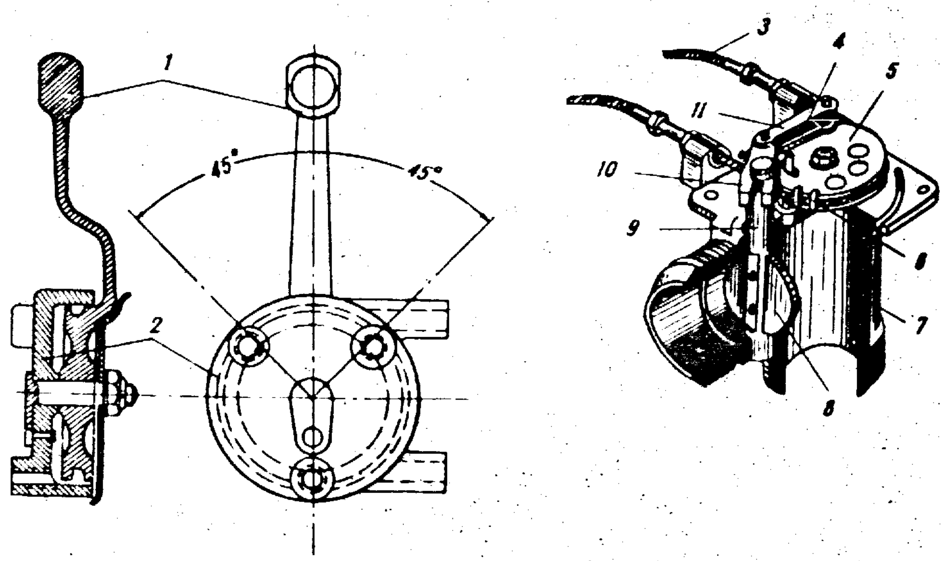


FIG.210. COCKPIT AIR SUPPLY VALVE
1 – valve control handle; 2 – control unit body; 3 – Bowden cable; 4 – spring; 5 – roller; 6 – cylinder; 7 – shut-off valve; 8 – shutter; 9 – axle; 10 – guide; 11 – rod.

783M Non-Return Valve in Pressurization System

The non-return valve allows air to flow in one direction only, from the gine to the cockpit; with the engine stopped or the pipeline damaged, the valve ts off the air supply mains and prevents air leakage from the cockpit.

The valve body bears an arrow indicating the direction of airflow.

Cockpit Air Supply Valve, (Fig.210)

The cockpit air supply valve is installed in the cockpit. Its control handle as two fixed positions (the angle between them being 90°): OPEN and CLOSED.

The valve is remotely controlled through a cable system actuated by control ndle 1 mounted in the cockpit on the right-hand console.

Control handle sector 2 is connected with a roller of the air supply valve y means of cable 3.

The valve consists of a body with two pipe connections and steel shutter 8. utter pin 9 is linked to roller 5 by guide 10 and rod 11.

The valve body is made of duralumin, the shutter and its pin being fabricated rom steel.

The valve operates in the following manner: when turning the control handle nto one of the positions OPEN or CLOSED, the cable connecting the handle with he valve roller shifts and actuates the pin along with the shutter which is rned through ±45° as far as it will go, thereby opening or, on the contrary, losing the passage for air into the cockpit.

4. Arrangement of Units of Aircraft Cockpit Ventilation, Pressurization and Air Temperature Regulation System

The system units and assemblies are installed in the fuselage nose section n the following places:

(a) the TPTBK-45M air temperature regulator, PE-2 relay unit and the cockpit ir supply valve - in the cockpit on frame No.11;

(b) the valve, type 520Б, and the КБ safety valve - in the cockpit on frame No.6;

(c) the control handle of the cockpit air supply valve - in the cockpit on the right-hand console, at frame No.9;

(d) the pressure regulator, unit 2013B - between frames Nos 10 and 11, on the left-hand side of the canopy-carrying panel;

(e) the manifold delivering air to the canopy movable section - in the cockpit;

(f) the manifold delivering air to the pilot's feet - in the cockpit, at frame No.6, bottom;

(g) the manifold air supply limiter - port side, under the cockpit floor, at frame No. 7Б;

(h) the УВПД-20 altitude and pressure differential indicator - in the cockpit on the left-hand console, between frames Nos 7Б and 8;

(i) the four-position change-over switch of the cockpit air supply control system - on the left-hand console;

(j) the ДВ-3 fan - above the instrument panel, to the right;

(k) the non-return valve of the pressurization system, type 783M, - below, between frames Nos 12 and 13;

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25X1

(l) the turbocooler, unit 2323 - to the left, at frame No.15;

(m) the air cooler - between frames Nos 20 and 22;

(n) the cooling air outlet duct of the air cooler - in the hatch between frames Nos 21 and 22, to the right of the axis of symmetry, below;

(o) the air distributing valve, unit 525, on frame No.22, bottom;

(p) the pipe connection taking air off the engine compressor - at the engin bottom, port side, at frame No.26.

Chapter VIII

COCKPIT CANOPY AND EJECTION SEAT

The cockpit canopy and ejection seat present an ejection seat system CK designed to ensure the pilot's bailout at the aircraft indicated airspeeds of up to 1100 km/hr.

COCKPIT CANOPY

General

The cockpit canopy is intended to close the pressurized cabin, protect the pilot from the effects of the airflow and provide a normal field of vision during flight and landing. In addition, the cockpit canopy is used to protect the pilot from the on-rush airstream during bailout.

The cockpit canopy (Fig.211) is a stream-lined transparent superstructure over the fuselage upper part between frames Nos 6 and 11 and consists of:

(a) movable section;

(b) transparent windshield;

(c) side shields.

The cockpit canopy is furnished with the following systems:

(a) pressurization and control system;

(b) canopy jettison system;

(c) ejection seat grip system;

(d) de-icing system.

When opening the cockpit, the canopy movable section moves up and forward turning about the axle located at frame No.6. The canopy movable section is lifted by air cylinders.

The pressurization of the canopy[x] is effected after its lowering and fixing by locks. The depressurization is performed either automatically by opening the canopy locks or independently with the aid of a pressurization handle. The sealing hose is located on the fuselage.

The air pressure in the sealing hose is 1.7 - 2.55 kg/cm^2. The pressure in the hose is less than that after the reducer due to a pressure drop caused by the resistance in the non-return valve.

When closed, the cockpit canopy is secured to the fuselage at eight points by means of 6 operating locks installed in the canopy-carrying panel and 8 emergency locks on the canopy. The canopy emergency locks are of the bomb shackle type.

[x]From now on, in similar expressions the term "canopy" will denote its movable section.

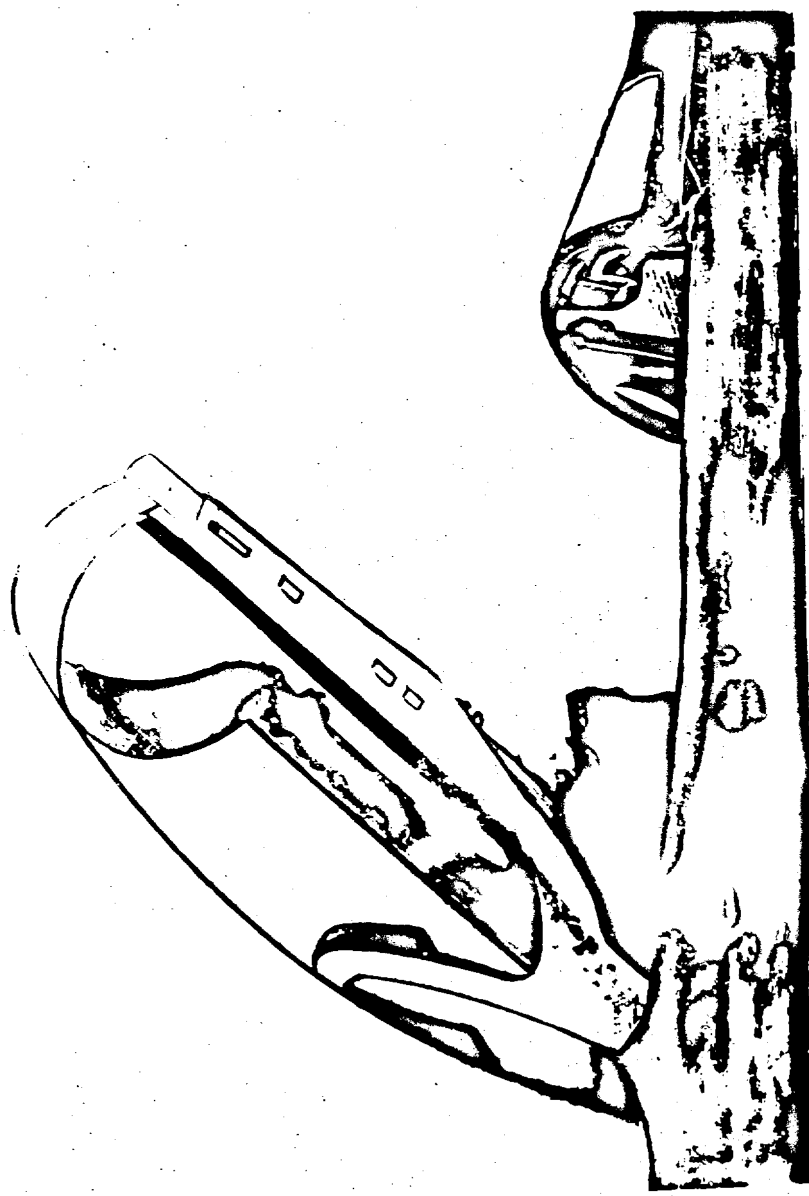

FIG.211. COCKPIT CANOPY. GENERAL VIEW

The jettisoning of the canopy is accomplished by a canopy jettison ...e located on the fuselage starboard side. The emergency locks are released ...ans of an explosive cartridge operated system. The tossing of the canopy is ...ected by lifting cylinders operated by air fed therein under a pressure of ... 130 kg/cm^2.

At the ejection with the canopy acting as a protective element, the canopy ...rried away from the fuselage by the seat. Such being the case, the canopy ...rgency locks are released by the seat trunnion pins.

The canopy jettison system is interlocked with a seat ejection gun so that ... of the gases shall be released from the ejection gun in the case of bailout ...r the canopy has been jettisoned. The gases are necessarily released in order ...btain permissible overloads due to the ejection without the canopy, since, ...his process, the ejection system weight is decreased. Owing to this fact, the ...lication of the full capacity of the powder charge might cause in this case ...rloads beyond the physical ability of human body.

I. CONSTRUCTION OF COCKPIT CANOPY
(Fig.212)

1. Canopy Movable Section

As regards its construction, the cockpit canopy movable section is made in ... form of a rigid framework carrying thereon a convex main glass and flat front ...ass.

The framework is composed of two longitudinal side beams coupled in the ...nt by a cast bracket of magnesium alloy and by an arch at the rear.

The longitudinal beams are riveted of an electron section, duralumin sections ... a skin. The rear arch is assembled of mechanically finished articles and has ...ut-out closed by special cover 3 cast of magnesium alloy. At the ejection with ... canopy used for protection, the cover is knocked out by the ejection seat ...gue parachute firing mechanism.

Main glass 1 is heat-proof organic glass, grade CT-1, 10 mm thick. The glass ... embedded in the side sections with the help of capron tape 17 glued to the ...ass. The tape forms a loop to be inserted into a special cavity of the side ... section and secured therein by rod 18.

At the front edge, the main glass is secured by means of capron tapes 11, ...th their one side glued to glass 1 and with the other, to frame 10 of front ...ass 9 and the cockpit canopy framework. Besides, tapes 11 are bolted to the ...ont glass frame and the canopy framework outer and inner edgings. In order to ...sure a good sealing in the joints, tape 14 of a rubberized cloth is glued to ...ner capron tape 11. Rubber gaskets 12 and 13 are glued to the outer and inner ...ralumin glass edgings at the contact points with the glass.

The rear edge of glass 1 has no attachment to the canopy framework. The joint ...tween glass 1 and canopy framework 4 is sealed with the aid of rubber sections 21 ...inforced by fabrics. Sections 21 are glued to the glass and framework and allow ... free movement of the glass with respect to framework 4. From outside, the clear...ce between the glass edge and framework 4 is covered with rubber section 2. ... section is reinforced by fabrics and glued to the glass only. To render the ...ass rear edge stronger, it is glued all over with capron tape 20. Rubber ...ock-absorbing section 22 is glued to framework 4.

The sealing of the canopy movable section in the joints between its members ... effected by the sealing varnish, grade У-20М.

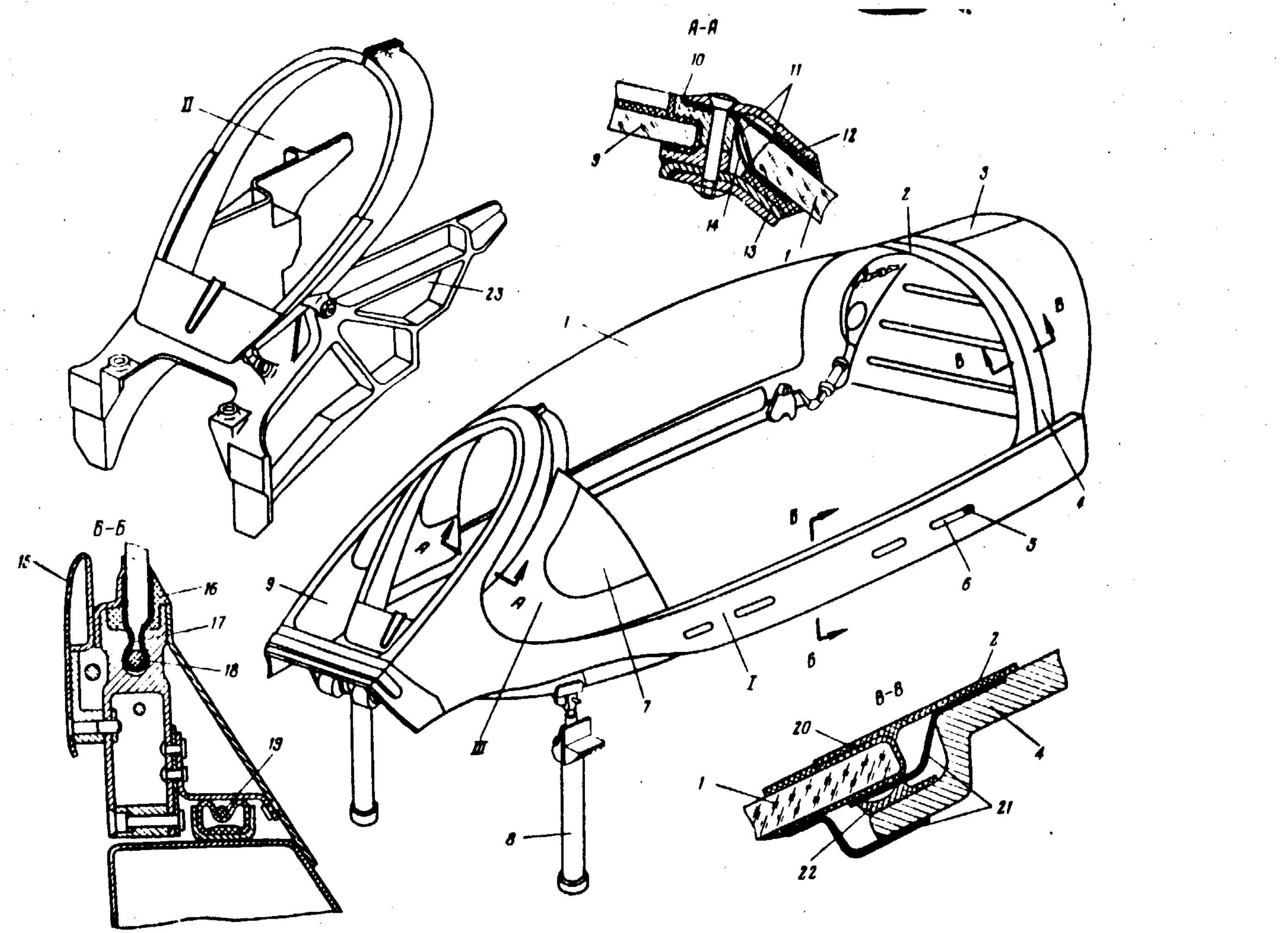

FIG.2'2. ONSTRUCTION OF COCKPIT CANOPY

I – cockpit canopy movable section; II – transparent windshield; III – side shield; 1 – main glass; 2 – rubber sec-
tion; 3 – access panel; 4 – rear ring; 5 – button; 6 – canopy lifting handle; 7 – side shield glass; 8 – canopy lift-
ing cylinder; 9 – front glass; 10 – front glass frame; 11 – capron tape; 12 – rubber packing; 13 – rubber packing;
14 – tape; 15 – air delivery pipe; 16 – У-30М sealing varnish; 17 – capron tape; 18 – rod; 19 – sealing hose;

 25X1

If there is no air in the aircraft air system, the canopy can be lifted by hand, for which purpose handle 6 is mounted on the left-hand beam. When inoperative, the handle is arranged in the beam recess and fixed by button 5.

2. Transparent Windshield

The transparent windshield of armour glass (II) is located immediately before the front glass of the canopy movable section. It serves three purposes:

(a) it protects the pilot at the front from direct hits of bullets, shells and splinters;

(b) the canopy rollers ride over the shield in case the bailout is performed with the canopy used for protection;

(c) it protects the pilot from the on-rush airflow after the canopy has been jettisoned.

The transparent windshield is a [illegible]-sheet triplex, 62 mm thick, mounted in a rigid steel frame which is attached to sight bracket 23 by four bolts.

3. Side Shields

Located at the sides of the transparent shield are two side shields (III) having small windows 7 furnished with organic glass. In combination with the transparent shield, the side shields form a sort of a baffle which protects the pilot from the effects of the airstream in the case of an emergency jettisoning of the canopy.

II. CANOPY PRESSURIZATION AND CONTROL SYSTEM
(Fig.213)

The cockpit canopy is attached to the fuselage mounting bracket by means of two bolts which serve as the axles of rotation in case the canopy is being lifted or lowered.

The control of the canopy implies the opening and closing the operating locks, the lifting and lowering of the canopy. The latter is controlled by special handle 5 installed on the left-hand side of the canopy-carrying panel. The canopy sealing is effected through hose 3 by turning handgrip 14 located together with the canopy control handle 5 on a common axle. On the canopy-carrying panel and on the fuselage skin in the vicinity of canopy control handle 5, there are instructions for a proper application of the valve.

The canopy can be controlled and pressurized both from the inside and outside of the cockpit. For this purpose, the two-arm canopy control handle is provided with two arms: inside arm 13 and outside arm 15. The outside arm is arranged in a fuselage recess and retained therein by virtue of its own hooks and button 17. In this position, the outside arm has no kinematic linkage with the inside one. Button 17 pressed, arm 15 is extended; when turned down, it gets engaged with the inside arm, thus making possible the canopy control from the outside.

To retract arm 15, the latter should be pressed inwards until it disengages from the inside arm and then inserted into the recess so that the arm hooks shall go under the box stops; this done, fix the arm by button 17.

The outside pressurization is accomplished by turning shaft 16 with the aid of a screw-driver to be inserted into a slot at the shaft face end.

 25X1

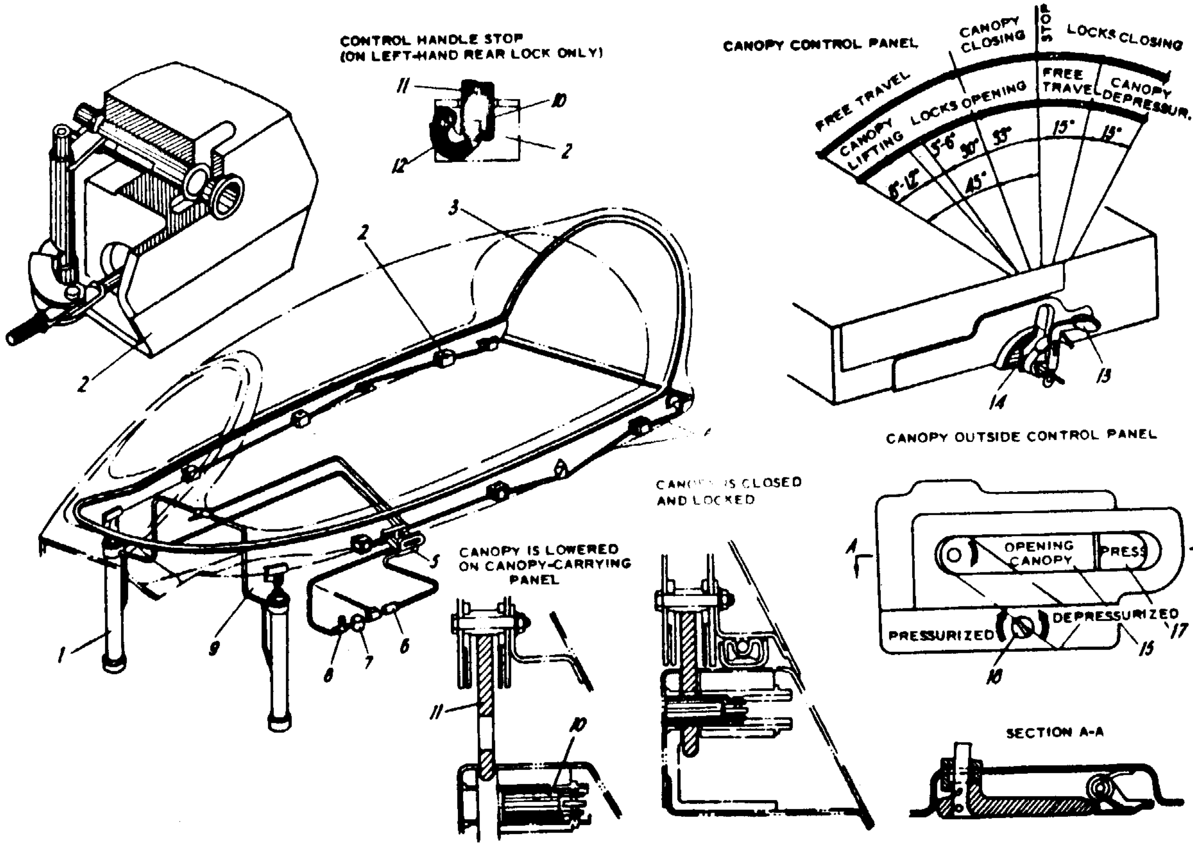

FIG.213. CANOPY PRESSURIZATION AND CONTROL SYSTEM

1 – canopy lifting cylinder; 2 – canopy operating lock; 3 – sealing hose; 4 – rod; 5 – canopy two-arm control handle; 6 – non-return valve; 7 – PB-1.5 reducer; 8 – air valve; 9 – pipeline; 10 – pin; 11 – canopy loop; 12 – stop; 13 – inside arm; 14 – pressurization handgrip; 15 – outside arm; 16 – splined shaft for canopy outside pressurization; 17 – button.

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25X1

The canopy is fixed in the lowered position by six locks 2 mounted in the canopy-carrying panel. Lock 2 is a cast bracket having a slot to accommodate the canopy loop. Bell-crank actuated pin 10 slides across the above slot. The bell-cranks of all the locks are connected by rods to a guide of the canopy control handle. In order to prevent the locks from snapping before the canopy is lowered, stop 12 is provided in the left-hand rear lock; the stop covers the slot in the place where pin 10 comes out. As the canopy is lowered, the canopy loop presses at stop 12 and allows pin 10 to get clear.

The canopy is lifted by cylinders 1 supplied with air from the air system through the canopy control valve. The canopy is lowered by gravity forcing the air out of cylinders 1 into the atmosphere.

The two-arm canopy control handle (Fig.214) is attached to panel 16 and box 1. The handle consists of rod 4 with inside arm 9, pressurisation handgrip 8 and guide 7. Arranged inside rod 4 is shaft 3 with outside arm 2 fitted thereon. Shaft 3 is pressed outwards by spring 6 and, when extended, becomes locked with rod 4 by two screws 5. Screws 5 and head slots of shaft 3 are asymmetric. Due to this asymmetry, the outside arm engages the inside one in its lower position only. This makes it possible to avoid injuries of hands in case the canopy is locked from the outside.

Guide 7 and handgrip 8 have a play of 30° and 15° with respect to arm 9 and rod 4, correspondingly. By taking advantage of the play of pressurisation handgrip 8, it is possible to pressurize and depressurise the canopy when arm 9 is locked in its extreme front position. A toothed sector of pressurisation handgrip 8 is engaged with canopy control valve 15 also located on panel 16. The projecting ends of shaft 3 and the outside of the valve axle are sealed with a stuffing-box seal and a rubber ring. When the outside arm is operated, shaft 3 deflects the inside arm by means of link 12 and prevents it from being fixed in the front position.

1. Canopy Air System (Fig.215)

The canopy air system is subdivided into the operating and emergency systems.
The operating air system is designed to pressurize and lift the canopy. It
comprises canopy lifting cylinders 5, sealing hose 8, canopy control valve 11,
air valve 12, PB-1.5 reducer 13 and non-return valve 14.

Canopy lifting cylinders 5 are installed on the sides of the canopy-carrying
panel in the neighbourhood of frame No.7.

Canopy control valve 11 is fastened onto the canopy control handle panel.
The sealing hose is laid in a special groove of the canopy-carrying panel. Air
valve 12 made integral with PB-1.5 reducer 13 and non-return valve 14 is instal-
led on the cockpit left side, in the area of frames Nos 7 and 7б. Air valve 12
includes a non-return valve and a safety valve.

The emergency air system tosses the canopy when the latter is jettisoned. The
emergency air system incorporates non-return valve 1 disconnecting the canopy
emergency air system from the aircraft air system at a pressure of 130 kg/cm^2;
emergency bottle 9 positioned in the front equipment compartment, port; emergency
valve 3 installed on the cockpit starboard in the region of frame No.6; air
cylinder 7 installed on the canopy mounting bracket and designed to release a
time delay lock during the canopy emergency jettisoning; non-return valve 6
separating the emergency air system from the operating air system and air
cylinders 5 which serve as the canopy tossing cylinders at the emergency jettison-
ing of the canopy. The canopy emergency air system is provided with connection 10

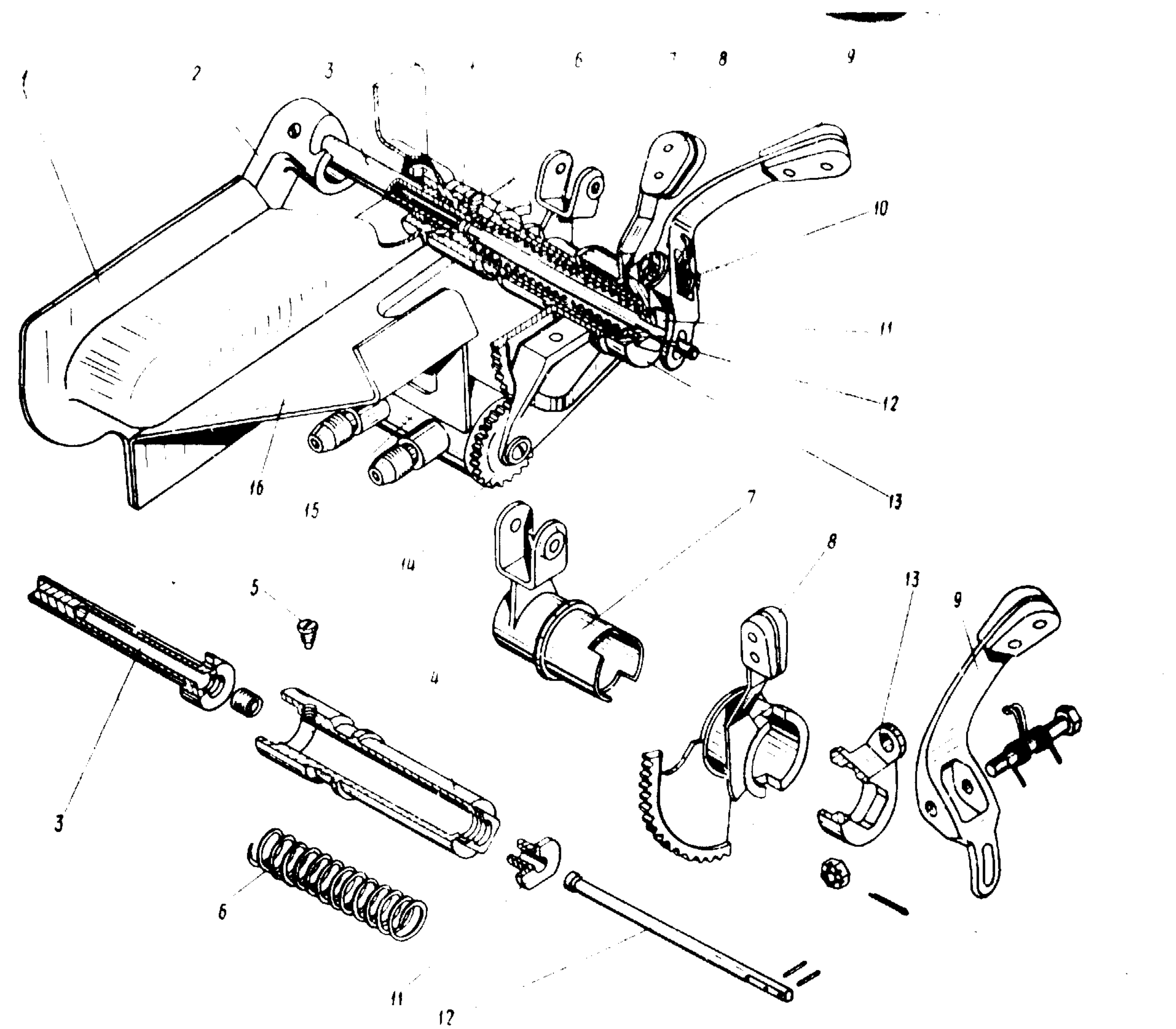
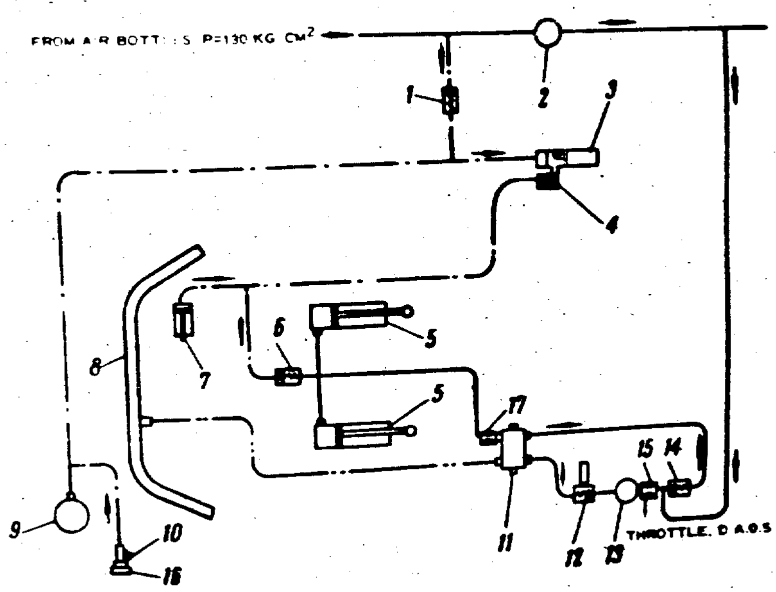


FIG.214. CANOPY TWO-ARM CONTROL HANDLE

1 – outside arm box; 2 – outside arm; 3 – shaft; 4 – rod; 5 – screw; 6 – spring; 7 – guide; 8 – pressurization handle; 9 – inside arm; 10 – spring; 11 – nut; 12 – link; 13 – bracket; 14 – gear; 15 – canopy pressurization and control valve; 16 – panel.



SYMBOLS
CANOPY LIFTING CYLINDER CONTROL SYSTEM.
P=50 KG CM^2
CANOPY PRESSURIZATION SYSTEM.
P = FROM 1.7 TO 2.95 KG CM^2
CANOPY EMERGENCY TOSSING SYSTEM.
P - FROM 110 TO 130 KG/CM^2

FIG.215. CANOPY AIR SYSTEM
1 – non-return valve; 2 – PB-50 reduction gear; 3 – emergency valve; 4 – filter; 5 – canopy lifting cylinders; 6 – non-return valve; 7 – canopy time-delay lock releasing cylinder; 8 – sealing hose; 9 – emergency bottle; 10 – connection; 11 – canopy pressurization and control valve; 12 – air valve; 13 – PB-1.5 reducer; 14 – non-return valve; 15 – throttle; 16 – MB-250M pressure gauge; 17 – throttle.

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used to charge and release air during scheduled operating procedures. To check pressure gauge 16 is introduced, which is mounted along with connection 10 in the landing gear nose wheel well.

2. Air System Units

Canopy Pressurization and Control Valve

(Fig.216)

The canopy pressurization and control valve has two cavities similar in construction. It consists of body 3, axle 1 with cams, and valves 6 and 7. Fitted over axle 1 is pinion 14 (See Fig.214) turned by a toothed sector of the pressurization handgrip.

The gear ratio is three, i.e. once the toothed sector is turned through 75°, the pinion and valve axle turn through 225°. The other end of the valve axle protrudes outside through the cockpit skin and has a spline which makes it possible to pressurize the cockpit from the outside by use of a screw-driver.

The principle of the valve operation is based on an alternative pressing of valves 6 and 7 by axle cams, valve 7 being acted upon directly by the cam and allowing air to flow into the valve cavity from the air system. Valve 6 is forced inside the valve body by means of guide 6 and releases the air from the valve cavity into the atmosphere. Connections 2 and 11 permit to communicate the valve cavities with the operating units, such as the canopy lifting cylinders and the sealing hose.

Connection 4 of the pressurization cavity is fitted with six releasing openings. Connection 5 of the cylinder control cavity has one releasing 1.2 mm dia. opening. The inlet connections of both cavities are provided with 0.5 mm dia. throttle openings.

Canopy Lifting Cylinder

The construction of the canopy lifting cylinder and the diagram of its attachment to the canopy-carrying panel are presented in Fig.217. Cylinders 8 are fixed inside mounting bracket 5 by means of connection 1 and pin 7, the latter both entering casing 3. Both connection 1 and pin 7 are kept from shifting in the longitudinal direction by locking pins 6. As the cockpit canopy is being lifted and lowered, the cylinders rotate on connection 1 and pin 7 simultaneously shifting in the longitudinal plane. The air is supplied for the cylinders by means of swivel airtight connection 2.

In order to prevent the lifted canopy from lowering in case the aircraft air system is depressurized, ground safety pins are inserted into rods 4; prior to lowering the canopy the safety pins should be removed.

Air Valve (Fig.218)

The air valve is composed of a non-return and a safety valves accommodated in one body. It consists of body 1, two slide valves 3 with rubber gaskets, springs, covers 5 and plug 7.

When air is fed into connection B, slide valve 3 of the non-return valve is pressed away and air flows through connection A into the pressurization valve.

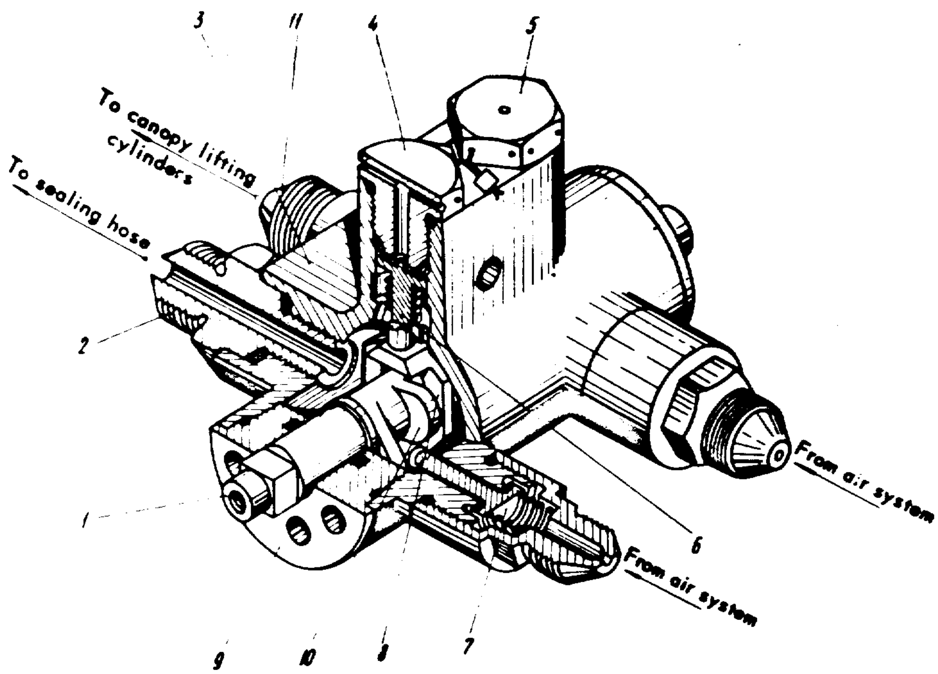


FIG.216. CANOPY PRESSURIZATION AND CONTROL VALVE
1 – axle with cam; 2 – connection; 3 – body; 4 – connection; 5 – connection;
6–7 – valves; 8 – guide; 9 – cover; 10 – cam; 11 – connection.

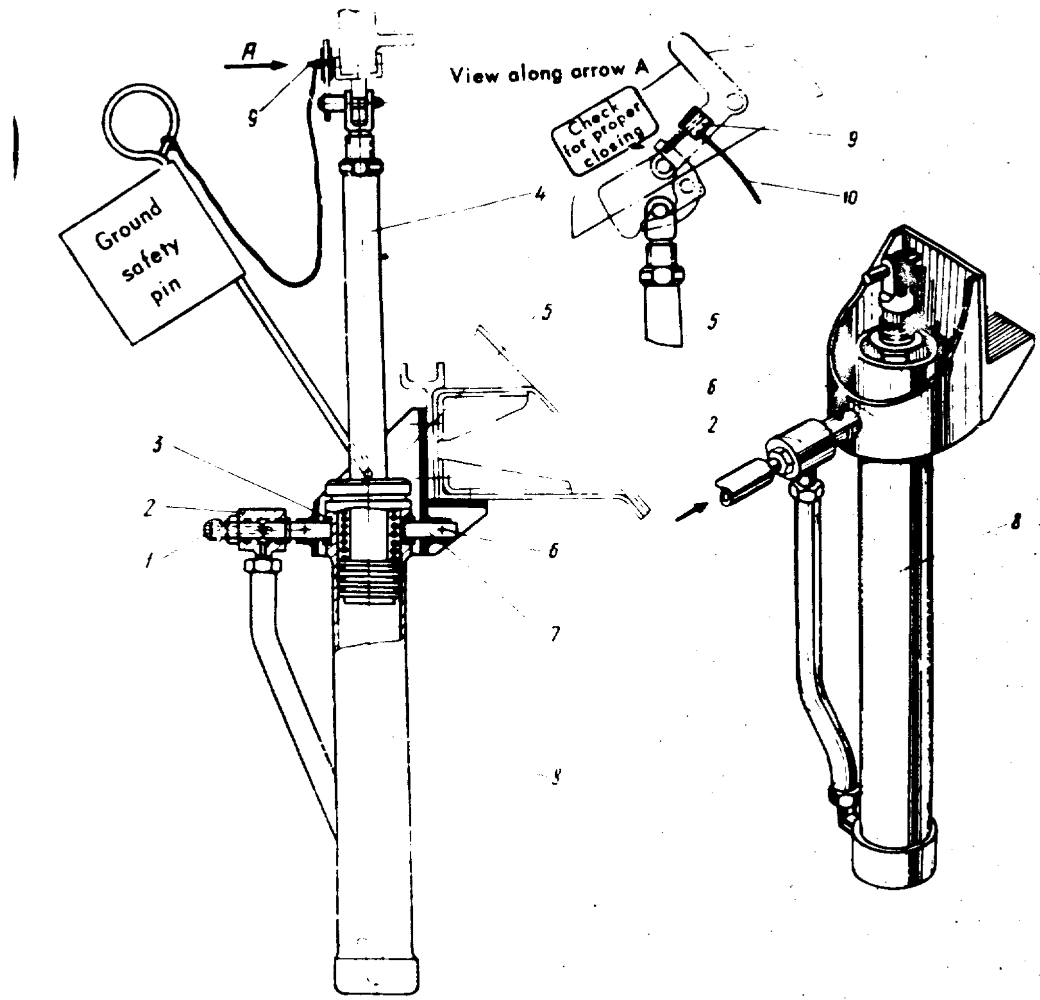


FIG.217. CANOPY LIFTING CYLINDER
1 – connection; 2 – swivel connection; 3 – casing; 4 – rod; 5 – cylinder attachment bracket; 6 – spline; 7 – pin; 8 – cylinder; 9 – emergency system retainer; 10 – cord.

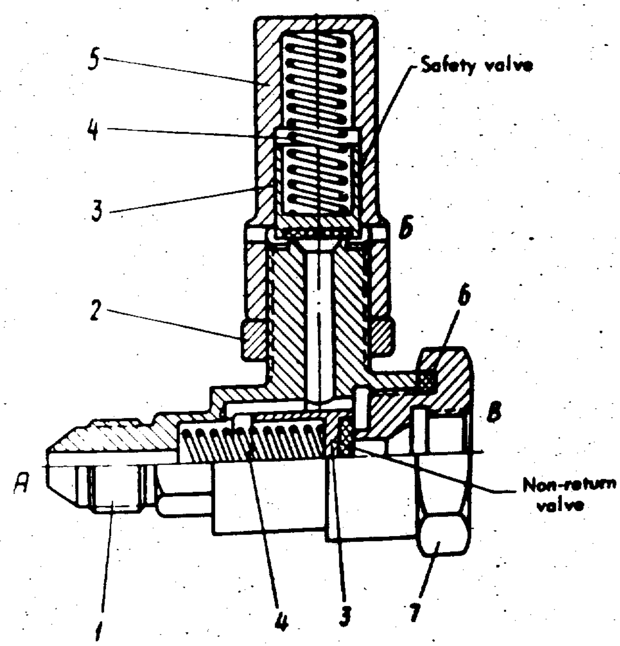


FIG.218. AIR VALVE
1 – body; 2 – locknut; 3 – slide valve; 4 – spring;
5 – cover; 6 – rubber packing ring; 7 – plug.

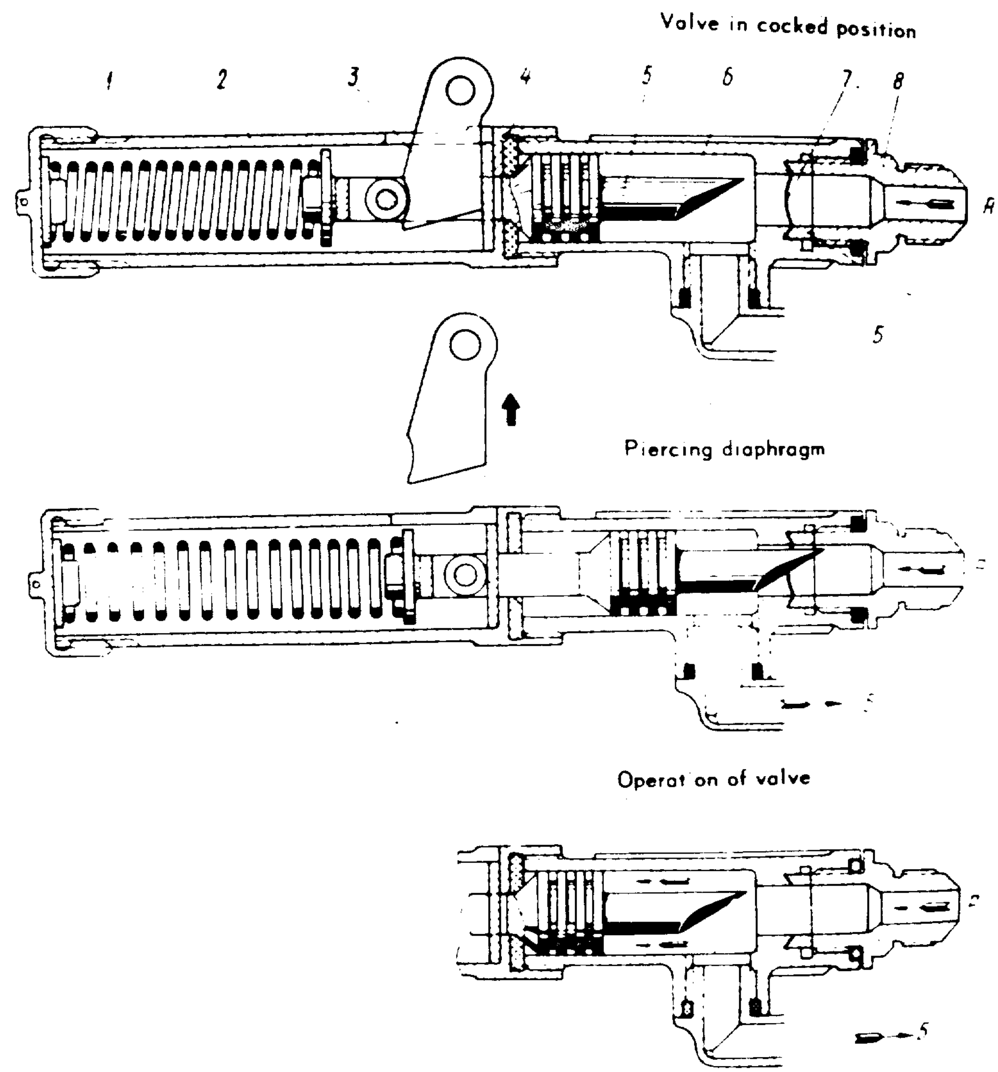


FIG.219. EMERGENCY VALVE (DIAPHRAGM VALVE)
1 – spring; 2 – pipe; 3 – cotter pin; 4 – rubber washer; 5 – striker; 6 – body; 7 – diaphragm; 8 – connection; 9 – bushing.

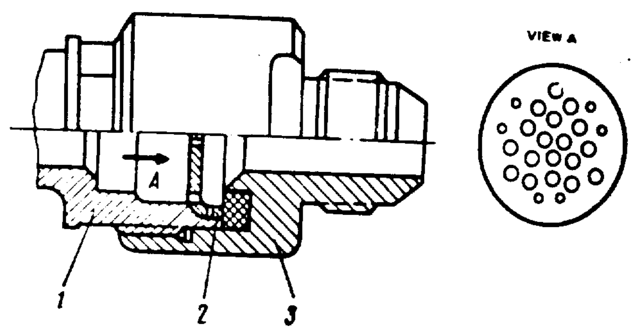


FIG.220. FILTER
1 – body; 2 – grid; 3 – cover.

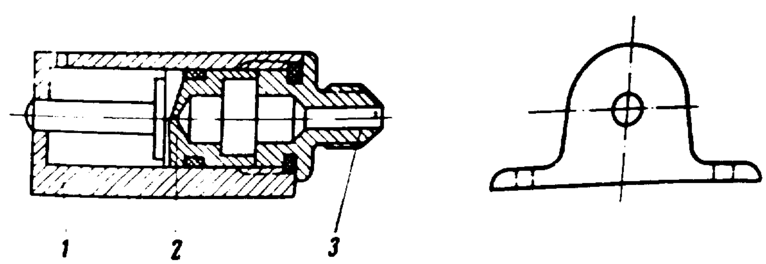


FIG.221. TIME DELAY LOCK OPENING CYLINDER
1 – body; 2 – rod; 3 – cover.

As air is flowing from connection A to connection B, spring 4 of the non-return valve presses slide valve 3 against the seat of plug 5 and stops the airflow.

When the pressure in the hose is higher than 2.8 kg/cm^2, slide valve 3 of the safety valve is moved aside and air is released through connection Б into the atmosphere.

Emergency Valve
(Fig.219)

The emergency valve serves to supply air from the emergency air system to the canopy tossing cylinders and to a cylinder used to open the time delay lock. The valve comprises body 6 with a pair of connections separated by diaphragm 7 made of 0.1 mm thick stainless steel sheets.

Diaphragm 7 is hermetically clamped by connection 8 between the body seat and bushing 9 to which the diaphragm is glued. To replace the diaphragm, connection 8 should be turned off. Air is supplied to connection A.

The instant cotter pin 3 is pulled out, striker 5 acted upon by spring 1 is pushed forward and pierces diaphragm 7. Due to the air pressure, the weakened diaphragm gets torn, striker 5 is pushed back and seals the valve body cavity by pressing with its taper part against the rubber washer. The filtered air is then fed to the operating units.

Filter (Fig.220)

The filter is used to trap pieces of the emergency valve broken diaphragm. It consists of body 1, grid 2, and cover 3.

In case the emergency valve has been actuated on the aircraft, the filter should be disassembled and diaphragm fragments removed.

Time Delay Lock Releasing Cylinder
(Fig.221)

The lock releasing cylinder is of a common construction and includes body 1, rod 2, and cover 3.

3. Canopy Control Valve and Handle Operation
(Fig.222)

Canopy Lifting

To lift the canopy, shift the canopy control handle from the extreme front position to the rearmost one. If the canopy is pressurized and the handle is turned through the initial 15°, the canopy will be depressurized. If the canopy is not pressurized, it is only the handle that moves during the first 15° of turning; then, the handle starts turning the pressurization handgrip and, thereby, the canopy control valve axle. The angle of the handle turning being in excess of 30°, a guide connected to the operating lock rods begins to turn. The handle being turned through 60 - 63°, the dowel pins of the operating locks completely release the canopy hinges and come out of the bracket recesses; an additional turn of the handle through 3° more allows air to enter the canopy lifting cylinders.

WARNING: The canopy should be lifted gradually 3 - 5 sec. after air has been delivered into the lifting cylinders. The positive retention of the canopy in the lowered position may cause a sharp tossing of the canopy and breakage of the attachment units of the lifting cylinder rods.

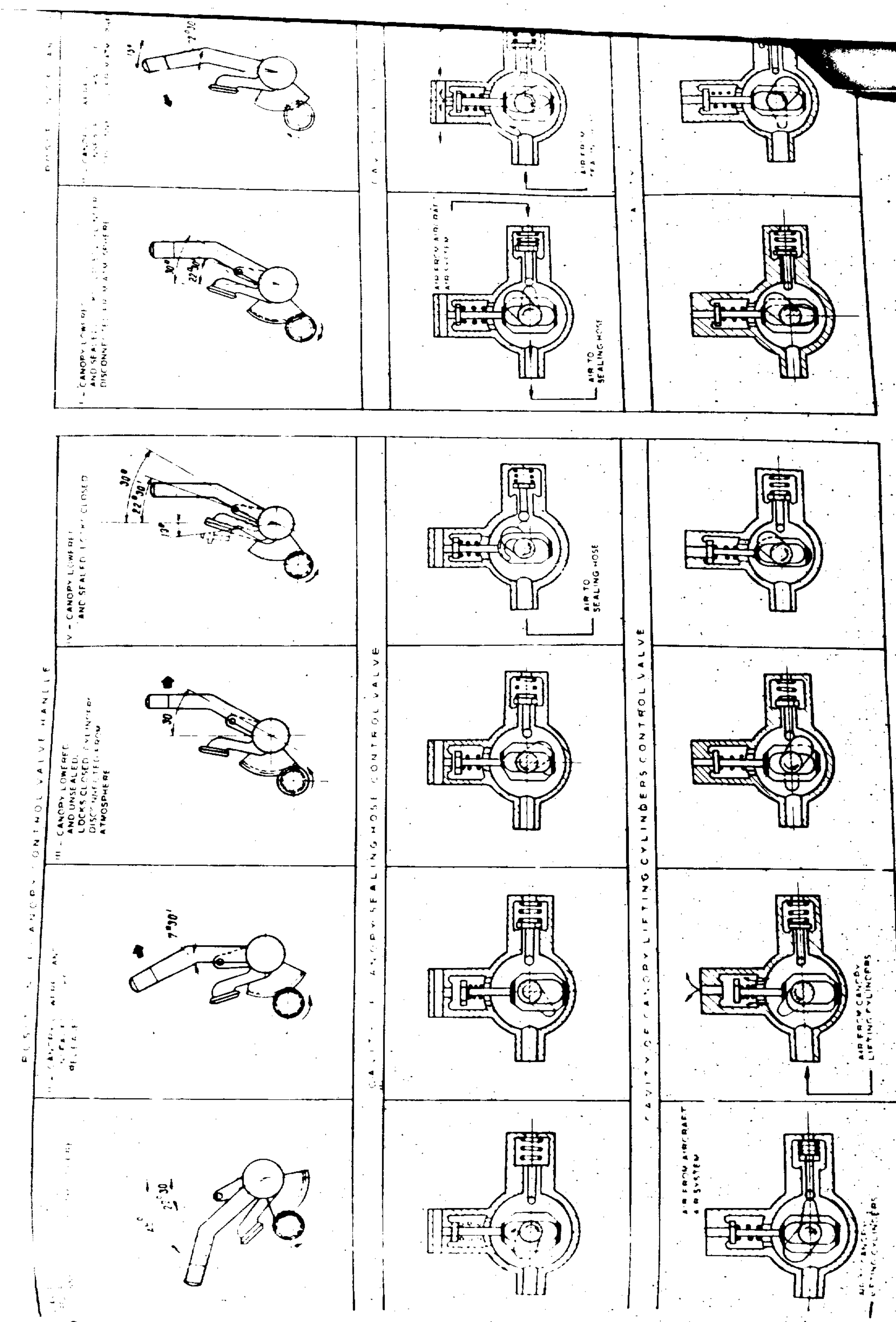
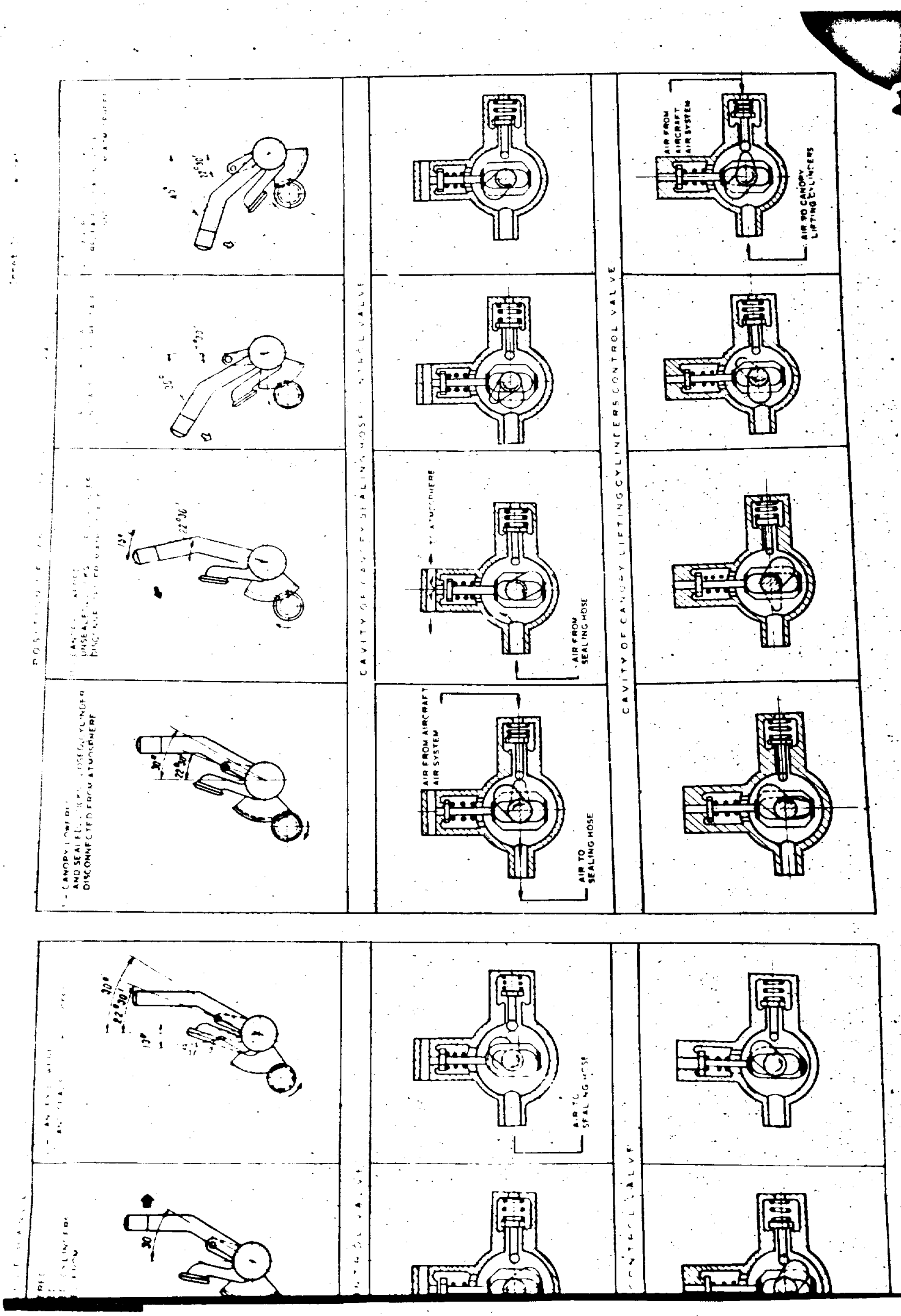


FIG.222. OPERATION OF CANOPY CONTROL VALVE AND HANDLE



...222. OPERATION OF CANOPY CONTROL VALVE AND HANDLE

Canopy Closing

To close the canopy, shift the canopy control handle from its extreme rear position to the extreme front one. At first, it is only the handle which moves. When the handle is turned through 15°, the pressurization handgrip play is taken up; the handgrip starts turning, too, and makes the canopy control valve axle rotate. The control handle being turned through 30 - 40°, the cylinder cavity release valve gets open, air escapes from the canopy lifting cylinders to the atmosphere and the canopy begins lowering. Upon being turned through 45°, the canopy control handle becomes fixed, since locking pin of the rear left-hand lock is retained by the stop (See Fig.213). The canopy completely lowered, shift the handle slightly forward and close the canopy locks.

When the handle is 3° to 6° short of its extreme front position and before it enters the panel recess, the cylinder control cavity release valve gets closed. The purpose of doing so is to prevent air from escaping out of the aircraft air system through the canopy tossing cylinders and canopy control valve in case of canopy jettisoning.

To pressurize the canopy, the pressurization handgrip should be pushed 15° forward.

WARNING: A positive retention of the canopy in its lifted position may result in its abrupt drop onto the canopy-carrying panel.

The canopy should be gradually lowered for not more than 15 sec. following the moment the canopy control handle is moved. A delay of up to 8 sec. is allowable in starting to lower the canopy.

III. CANOPY JETTISON SYSTEM

(Fig.223)

To open the cockpit in emergency, the canopy is jettisoned with the aid of a special system by turning canopy jettison handle 5.

The canopy jettison system embraces the following systems and units:

(a) canopy emergency locks;

(b) explosive charge actuated system for opening emergency locks (canopy jettison gun 8, explosive charge actuated cylinders 7 and wiring for explosive charge operated units);

(c) canopy tossing system (canopy emergency air system);

(d) canopy jettison handle.

The canopy emergency locks comprise hinge lock 3, six emergency locks 6 and two locks fixing lifting cylinder rods 4 connected to each other by bars.

In the case of jettisoning, the emergency locks are opened by means of explosive charge actuated cylinders 7 whose rods turn the fixing levers of rear emergency locks 6 and open all the locks by virtue of the bars.

1. Canopy Jettison System Units

Hinge Lock

(Fig.224)

The hinge lock is attached to the front bracket of the canopy framework and has two similar sections. It is composed of body 1, grips 4 and 5, pawl 2 and sector shaft with bell-crank 3. The lock body is a bracket cast of electron. Shafts 3 of both sections are rigidly coupled to each other. When shaft 3 turns, pawl 2 gets free and grips 4 and 5 go apart.

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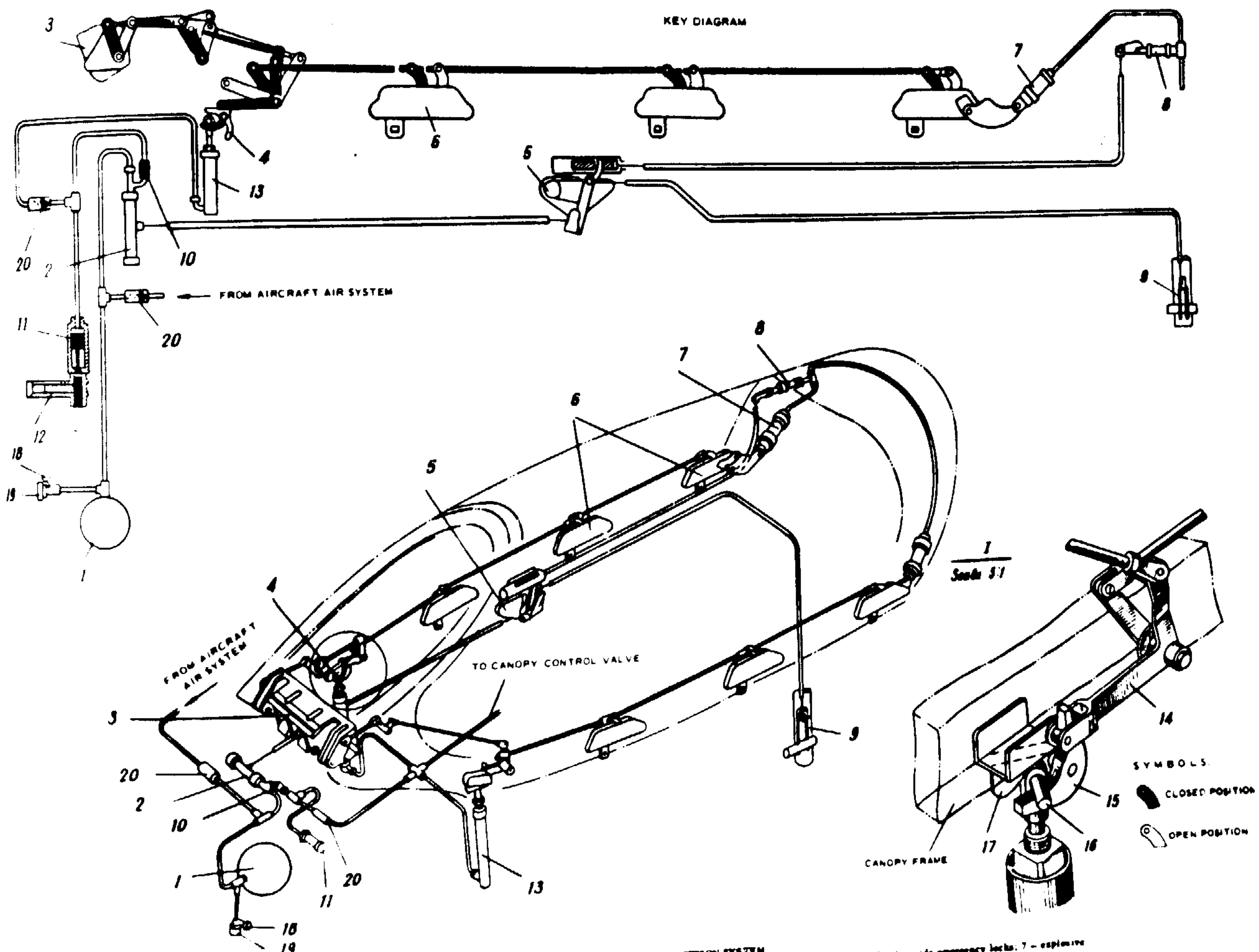

FIG.223. CANOPY JETTISON SYSTEM

1 – emergency bottle, 2 – emergency valve; 3 – hinge lock, 4 – cylinder rod fixing lock; 5 – canopy jettison handle; 6 – side emergency locks; 7 – explosive charge actuated cylinder; 8 – canopy jettison gun, 9 – cotter pin of TCM-2500-38 release mechanism, 10 – filter; 11 – time delay lock opening cylinder. 12 – canopy time delay lock, 13 – canopy opening cylinder, 14 – bell-crank; 15 – pawl, 16 – shaft; 17 – bracket; 18 – connection for charging and releasing ... bottle during scheduled maintenance; 19 – MB-250M pressure gauge, 20 – non-return valve.

Side Emergency Lock
(Fig.225)

The side emergency locks are installed in the electron sections of the canopy framework side beams. The lock mechanism is assembled in detachable body 5 and consists of levers 2 and 4 and bell-crank 3 fitted over the sector shaft. Loop 1 is fixed in the lock by means of a shaft mounted on lever 2.

When bell-crank 3 turns, levers 2 and 4 are hinged back and loop 1 becomes free.

Lifting Cylinder Rod Fixing Lock
(Fig.223, place I)

The lifting cylinder rod is secured to the canopy framework by means of bracket 17 whose recess accommodates rod shaft 16. The shaft is retained from moving downward by pawl 15 which is fixed in the operating position by bell-crank 14 connected to the lock control wiring. When bell-crank 14 is thrown back, pawl 15 turns and releases shaft 16.

Canopy Jettison Handle
(Fig.226)

The canopy jettison handle is located on the right side of the canopy-carrying panel. It performs three functions: switches on the emergency valve, actuates the canopy jettison gun, and pulls the cotter pin out of the releasing valve of the TCM-2500-38 seat ejection gun.

The handle is two-arm lever 6, the lower end of which carries hinge handle 8 connected to the cotter pin of the emergency valve through a cable. The emergency valve cotter pin is pulled out with a shift of hinge handle 8.

The other end of lever 6 enters drive mechanism 4 of the canopy jettison gun. When the handle is pulled, lever 6 pushes forward plunger 5 linked through a cable to a release lever of the canopy jettison gun.

Lever 6 is fixed in the forward position and can be pulled only in case handle 8 has already been placed in a horizontal position.

The cable connecting the release valve cotter pin of the TCM-2500-38 seat ejection gun passes through roller 3 and gets joined to lever 6.

Canopy Jettison Gun
(Fig.227)

The construction of the canopy jettison gun is the following.

Two cartriges 2, type ПВ-1 РОКС, are inserted in casing 1 and closed by locking plunger body 4, inside which travels striker 6 loaded by spring 5. When cocked, striker 6 is retained by release lever 10. The instant lever 10 turns, striker 6 becomes free and pierces the primer caps of cartridges 2.

2. Process of Canopy Jettisoning
(Fig.229)

When hinge lever 1 of the emergency jettison handle is shifted, the emergency valve cotter pin is pulled out. Air from the emergency air system enters the cylinder for opening canopy time delay lock 3 (the canopy time delay lock is

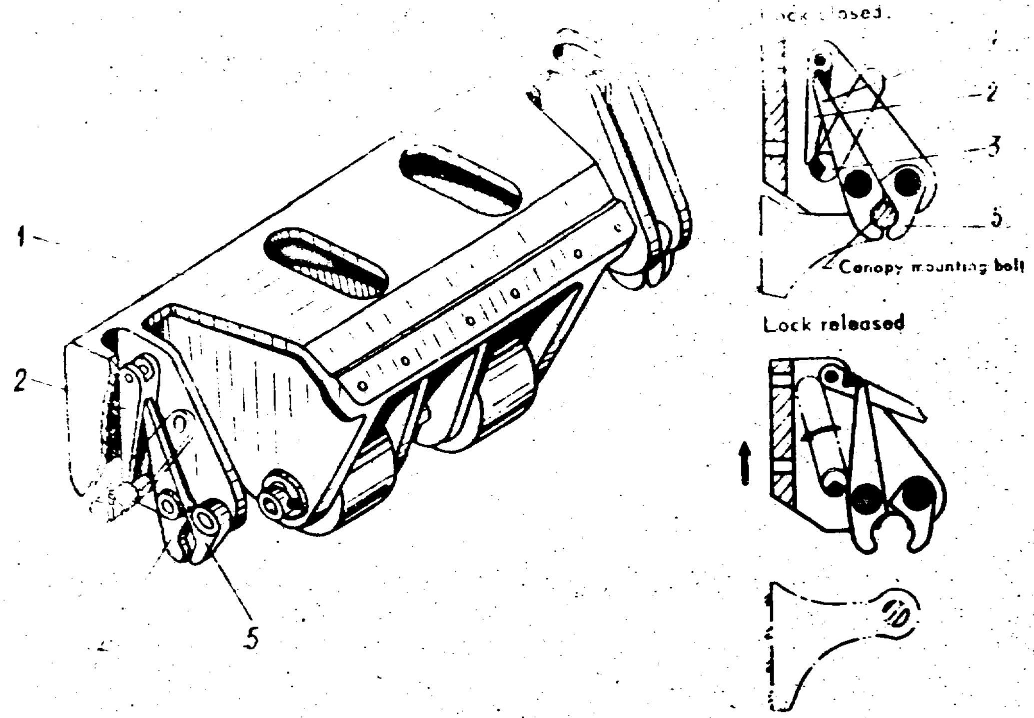

FIG.224. HINGE LOCK
1 – body; 2 – pawl; 3 – shaft; 4, 5 – grips

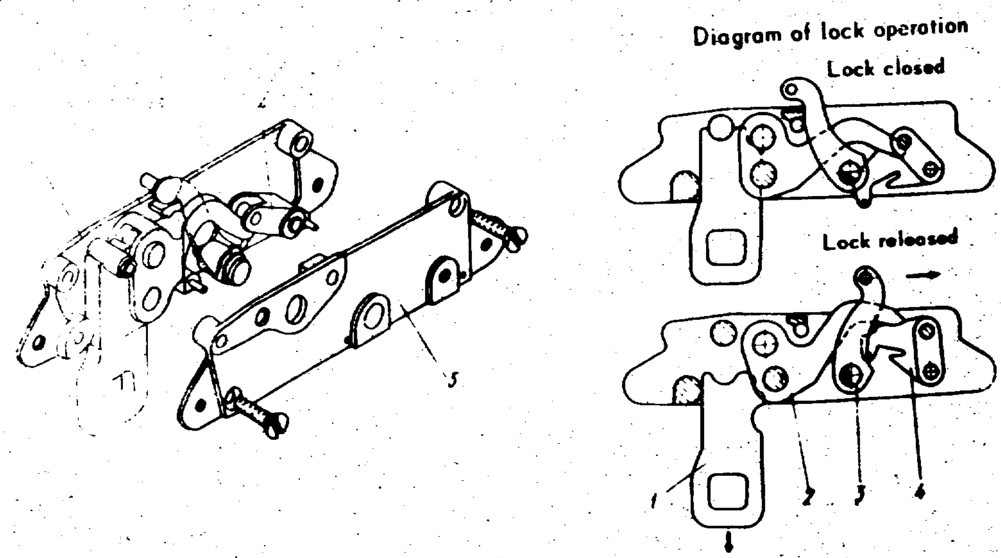

FIG.225. SIDE EMERGENCY LOCK
1 – loop; 2–4 – levers; 3 – bell-crank; 5 – body.

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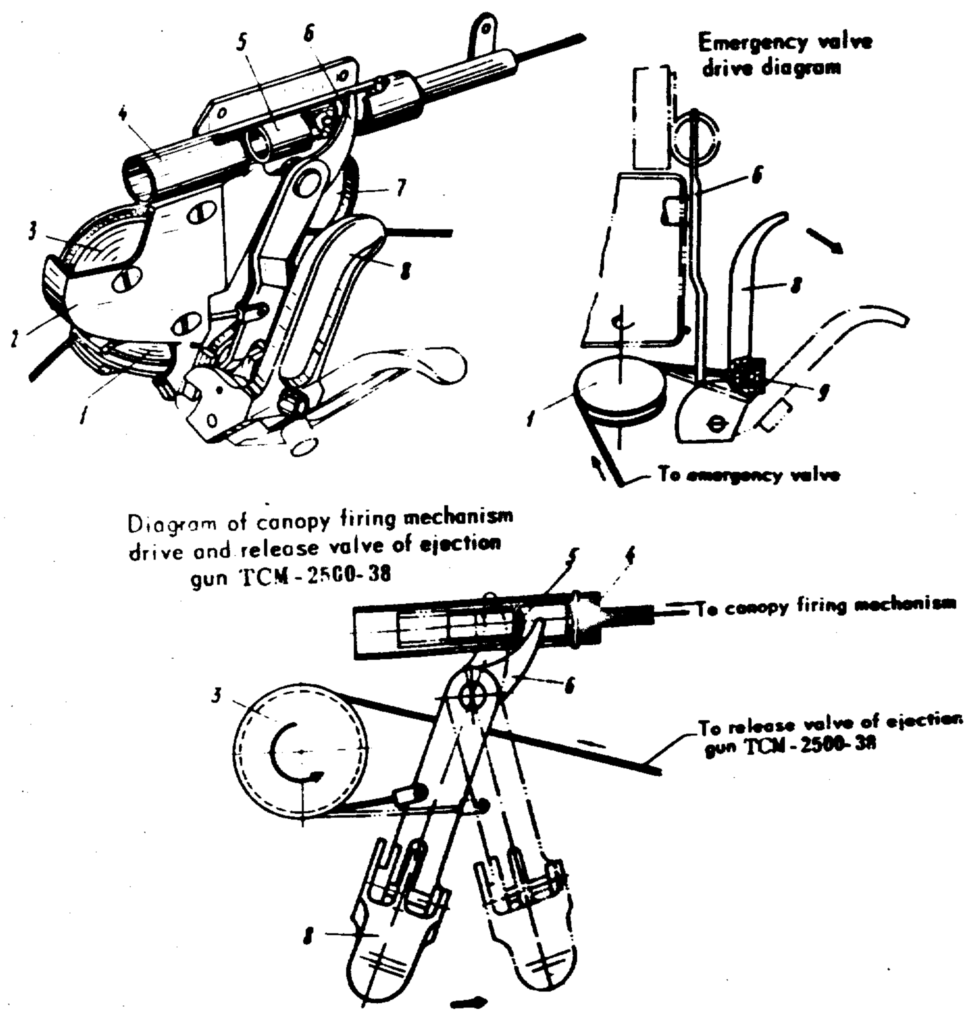

FIG.226. CANOPY JETTISON HANDLE

1, 3 – rollers; 2 – cover; 4 – jettison gun drive; 5 – plunger; 6 – lever; 7 – bracket; 8 – hinge grip; 9 – bushing.

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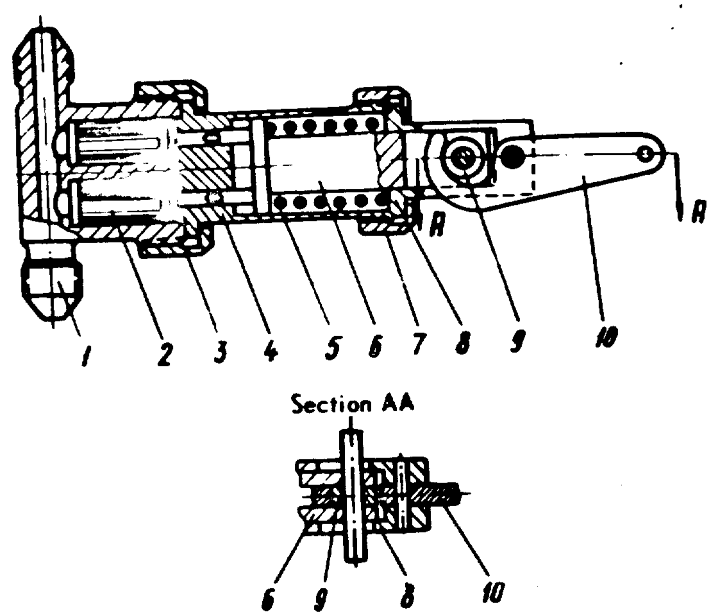

FIG.227. CANOPY JETTISON GUN
1 – body; 2 – cartridge ПR-1; 3 – nut; 4 – locking plunger; 5 – spring; 6 – triker; 7 – nut; 8 – sleeve; 9 – roller; 10 – release lever.

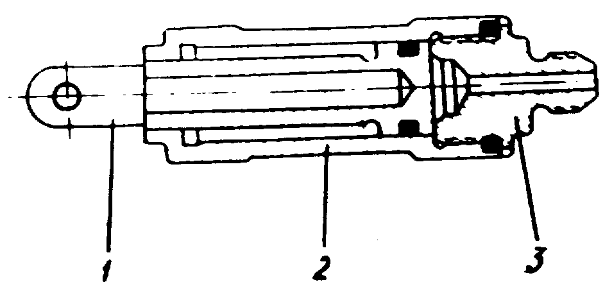

FIG.228. EXPLOSIVE CHARGE ACTUATED CYLINDER
1 – rod; 2 – body; 3 – cover.

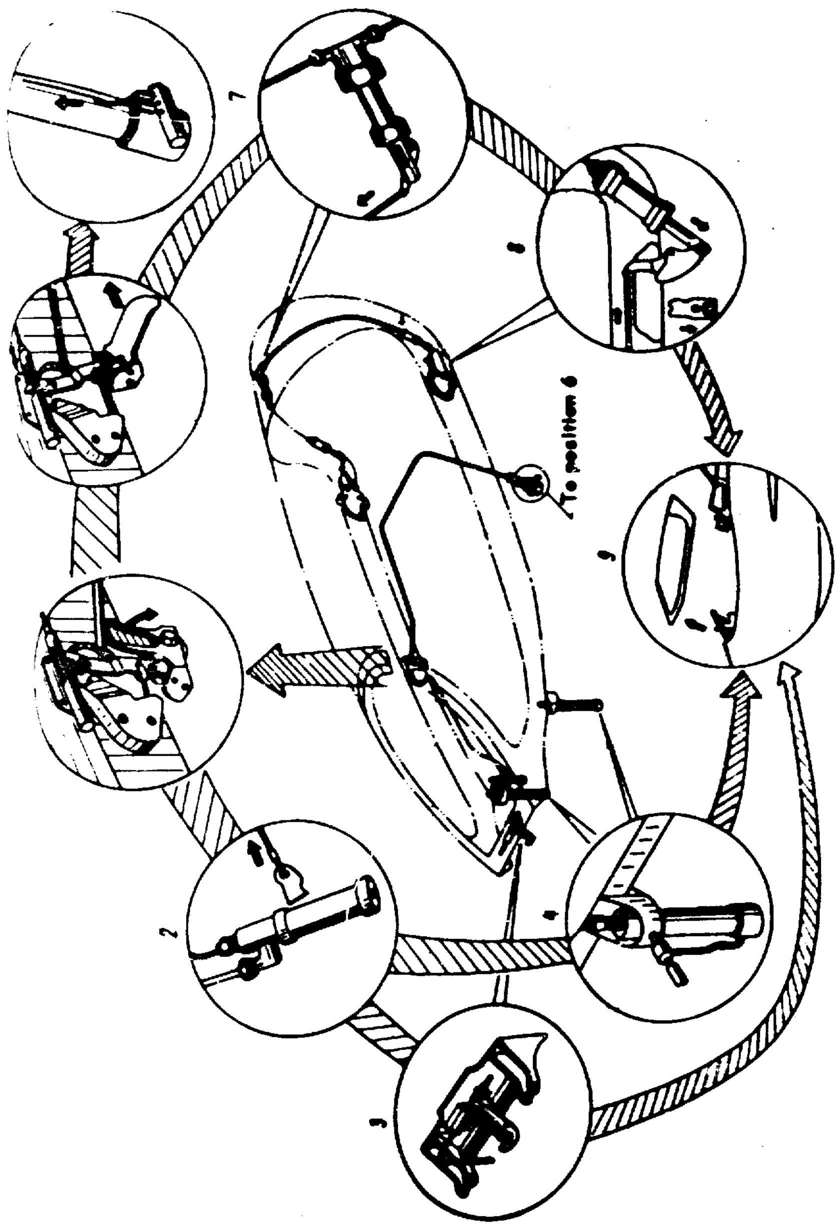

FIG 229. CANOPY JETTISONING DIAGRAM

described in the Section "Retention of Canopy by Seat") and canopy tossing cylinders 4 creating a tossing stress prior to releasing emergency locks.

When canopy jettison handle 5 is shifted, canopy jettison gun 7 is set in operation. Gases produced in the canopy jettison gun as a result of the explosion of two cartridges, type POKC, enter explosive charge actuated cylinders 8, which causes the emergency locks to open up. The canopy is tossed and carried away by the on-rush airflow.

Along with the operation of canopy jettison gun 7, release valve cotter pin 6 of the TCM-2500-38 ejection gun is pulled out by shifting canopy jettison handle 5.

IV. CANOPY-TO-SEAT GRIP LOCK SYSTEM

(Fig.230)

If the canopy is used as a protective element during ejection, the former is separated from the fuselage and retained by the ejection seat. For this purpose, a canopy-to-seat grip lock system is mounted on the canopy which incorporates the following units:

(a) canopy emergency locks (described under Section "Canopy Jettison System");

(b) seat grip locks (front 4 and rear 6);

(c) canopy time delay lock 1.

During ejection, the seat trunnion pins enter the recesses of rear locks 6, turn their levers and release the canopy emergency locks with the aid of rods 9 and bell-cranks 10. The time delay lock retains the canopy nose section from lifting after the emergency locks have been released. When the canopy whose rear section is moving along with the ejection seat takes such a position that the airstream starts pressing it to the fuselage, lock 1 gets open. The inserts of canopy front grip locks 4 enter the seat hinge supports and get locked in the latter.

When the canopy is separated from the seat, the seat levers press release levers 8 mounted on rear locks 6. Release levers 8 and bell-cranks 7 are mounted on the same shaft. The bell-cranks are linked by rods to the locking levers of front locks 4. The front locks get open and the canopy is turning around the seat trunnion pins. At the end of the turn, rear locks 6 get open and the canopy leaves the ejection seat.

To ensure a trouble-free operation of front locks 4, they are connected by a double-cable linkage which ensures releasing of both locks 4 when only one release lever 8 is pressed.

Units of Canopy Retention System

Rear Grip Locks

(Fig.231)

The rear locks are installed on the side beams of the canopy framework from the inside of the cockpit. The rear lock consists of rigid welded body 4 housing a mechanism which comprises grip 7, lever 3, stop 1 loaded by spring 2, and pawl 6 mounted with stop 1 on the same shaft. The seat trunnion pin presses grip 7 and turns it along with lever 3 which pushes rod 5 linked to the locking bell-crank of the rear emergency lock.

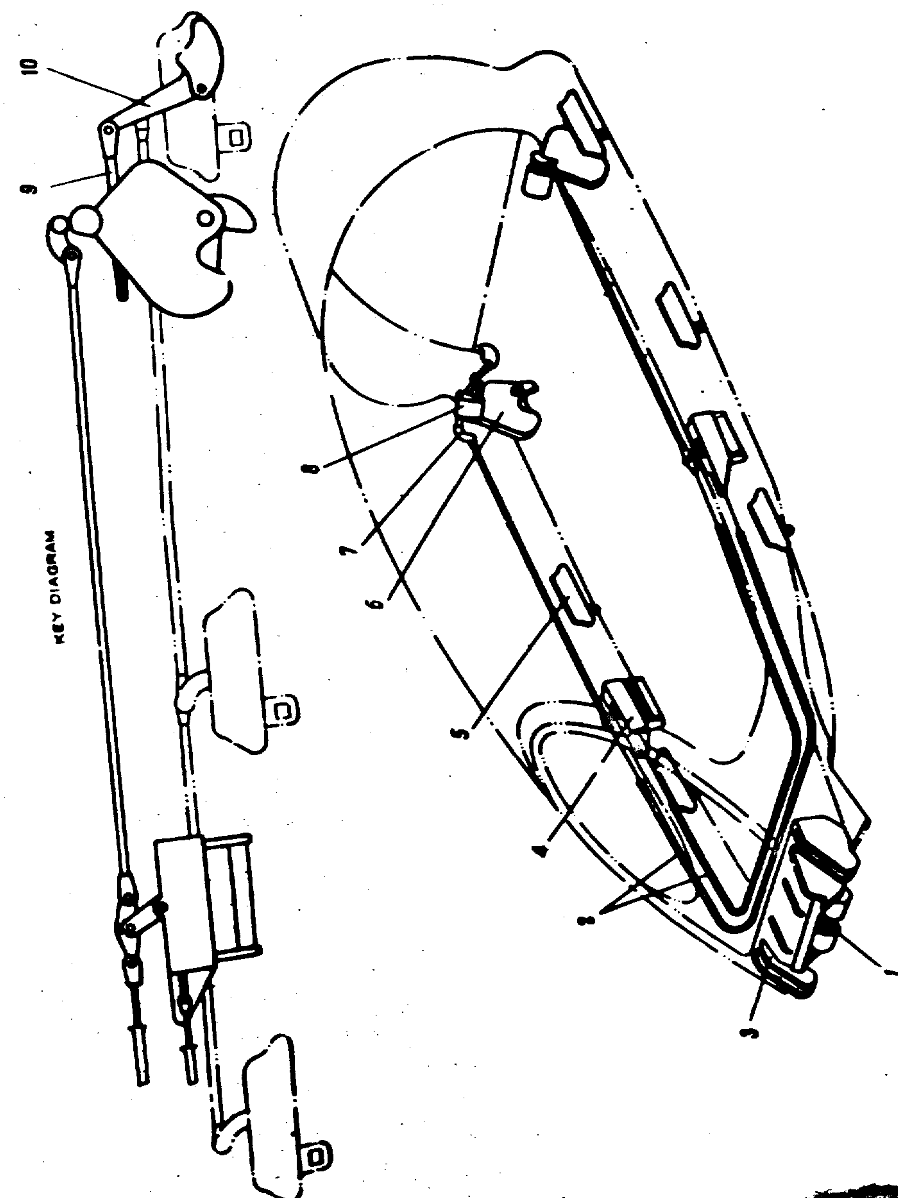

FIG.230. CANOPY-TO-SEAT RETENTION SYSTEM

1 – canopy time delay lock; 2 – cable tubes; 3 – hinge lock; 4 – front grip lock; 5 – aft emergency lock; 6 – rear grip lock; 7 – front grips releasing bellcrank; 8 – front grips release lever; 9 – rod; 10 – bellcrank.

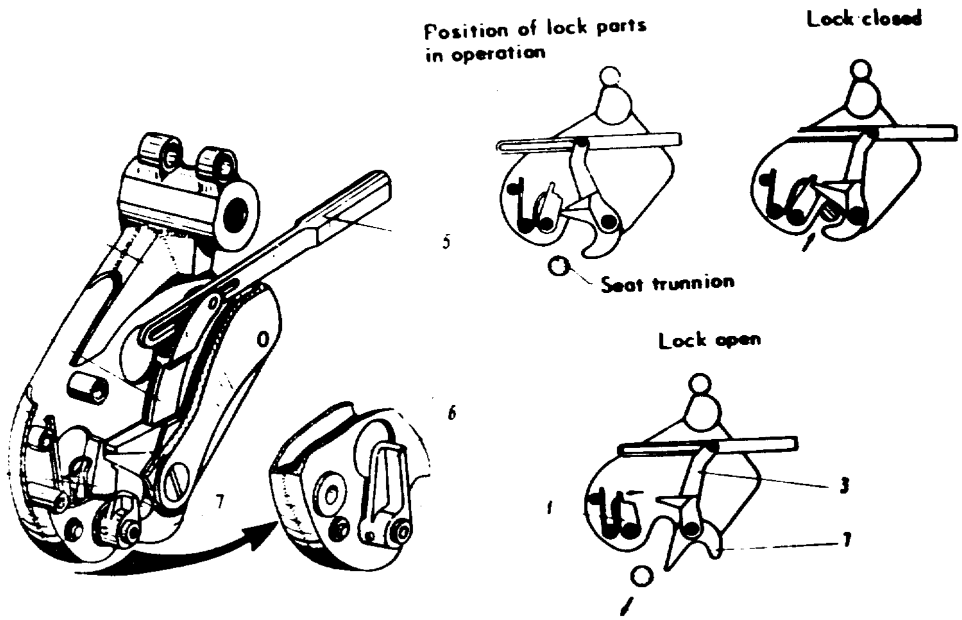

FIG.231. REAR GRIP LOCK
1 – stop; 2 – spring; 3 – lever; 4 – body; 5 – rod; 6 – pawl; 7 – grip.

When locked, grip 7 is retained by stop 1. When the canopy is pivoting on the seat trunnion pins, pawl 6 is pressed by the trunnion pin boss and disengages stop 1 from under grip 7 and the seat trunnion pin gets free.

Front Grip Locks

(Fig.232)

The front grip locks are also installed inside the cockpit on the canopy framework side beams. Insert 5 is arranged in body 3 and retained therein by four rollers 4 moved apart by cams 6. As lever 2 turns, cams 6 start rotating by virtue of rod 1. The released rollers leave the recesses of the insert which then freely separates from the body.

The double cable linkage connects lever 2 of one of the locks to rod 1 of the other lock and vice versa.

Canopy Time Delay Lock

(Fig.233)

The canopy time delay lock is installed on the canopy mounting bracket and consists of shackle 2 and lever 1.

When the canopy starts moving along with the ejection seat, the lock begins to turn. The end of lever 1 slides along bushing 6. The instant it reaches a cut-off section of the bushing, the lock gets open.

In the case of emergency jettisoning of the canopy, air cylinder 3 is filled with air, the cylinder rod knocks out axle 7 and occupies its place. Shackle 2 is moved forward, after which the canopy time delay lock can get open in any position.

V. DE-ICING SYSTEM

(Fig.234)

The purpose of the de-icing system is to remove ice from the canopy windshield by way of spraying ethyl alcohol over the entire surface of the windsheild.

Upon pressing button 4 located at the left upper part of the instrument panel, pneumatic valve 3, type ПУ-7, is switched on which delivers air under a pressure of 3 ±0.2 kg/cm² into alcohol tank 1. From tank 1, alcohol is supplied to manifold 2, from which it flows under plate 17. Passing under plate 17, the ram airflow sprays alcohol over the surface of the windshield.

As soon as the button is released, the delivery of air into the tank is cut off and the release openings of the ПУ-7 valve get open. From the tank, air is fed into valve 3 and released to the atmosphere.

4.9 lit. capacity alcohol tank 1 is fastened on a hinged cap of the special hatch in the fuselage front cone by bracing bands 12. Felt gaskets are placed between the tank and the bands.

Filler 21 housing filter 16 is hermetically sealed by cover 15 pressed by screw 14.

Alcohol is drained by turning off drain plug 10.

To avoid spilling of alcohol into the cockpit through the ПУ-7 valve in case air is released from the alcohol tank during flight in different piloting conditions, release pipe 18 is provided with two bands of 1 mm dia. release throttle openings 19 arranged at the pipe ends.

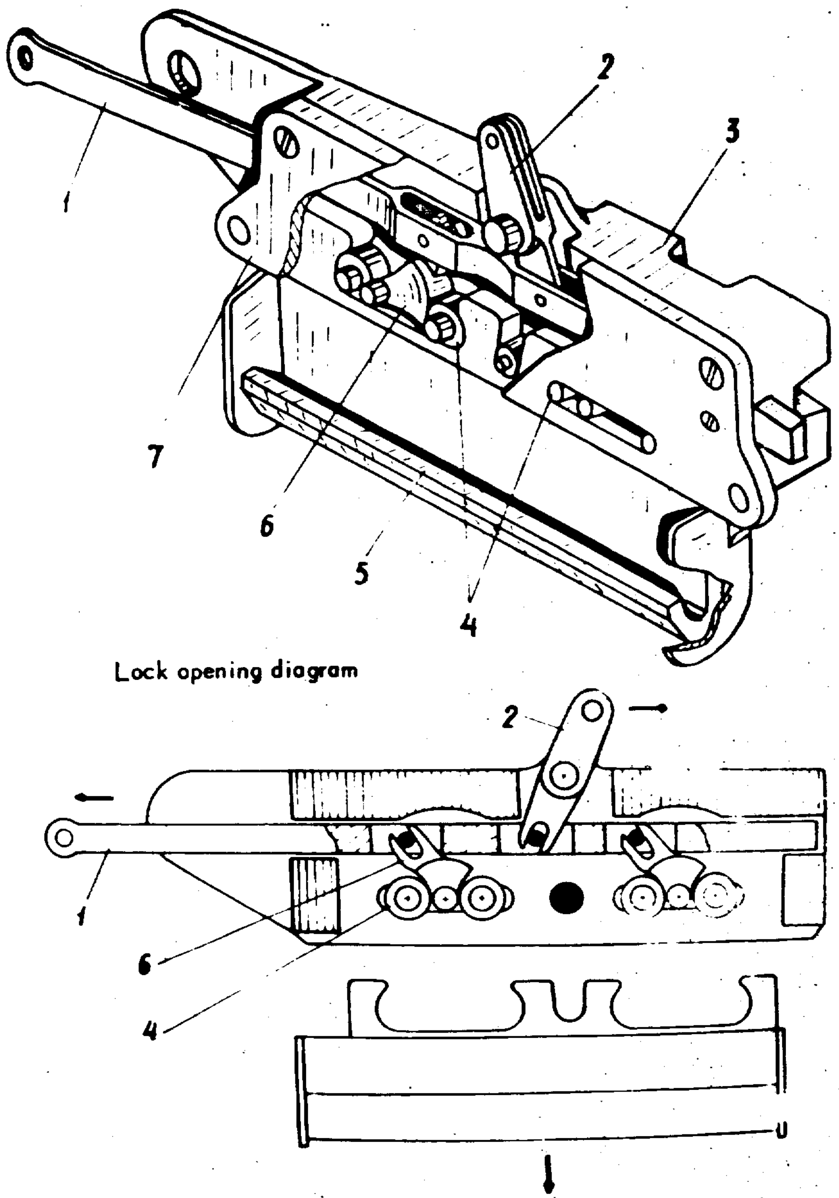

FIG.232. FRONT GRIP LOCK
1 – rod; 2 – lever; 3 – body; 4 – roller; 5 – insert; 6 – cam; 7 – body cover.

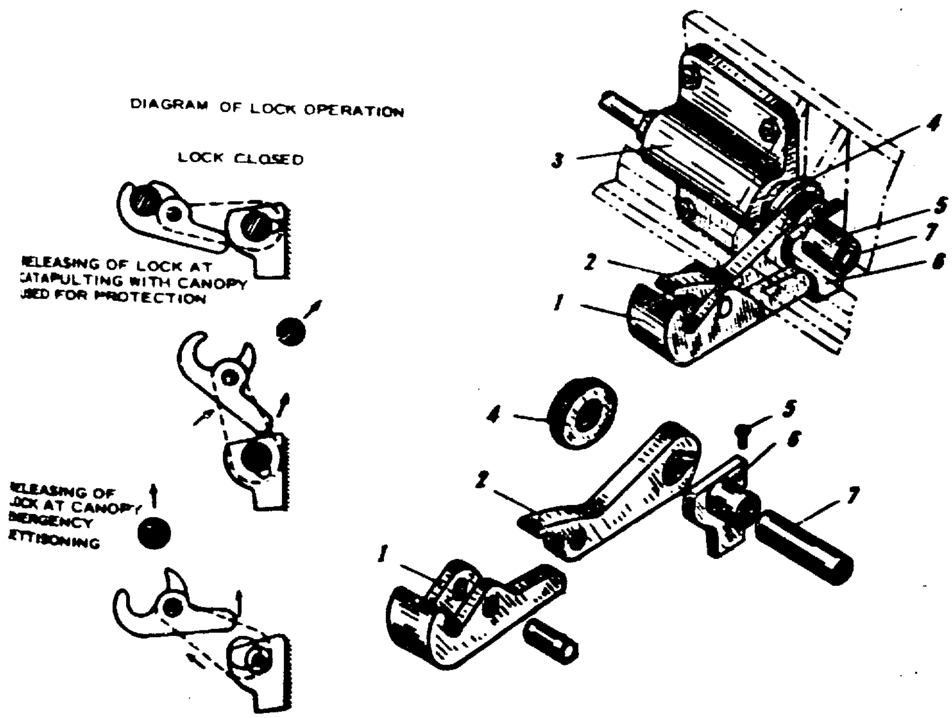

FIG.233. CANOPY TIME DELAY LOCK
1 – lever; 2 – shackle; 3 – air cylinder; 4 – bushing; 5 – centre rivet; 6 – bushing; 7 – axle.

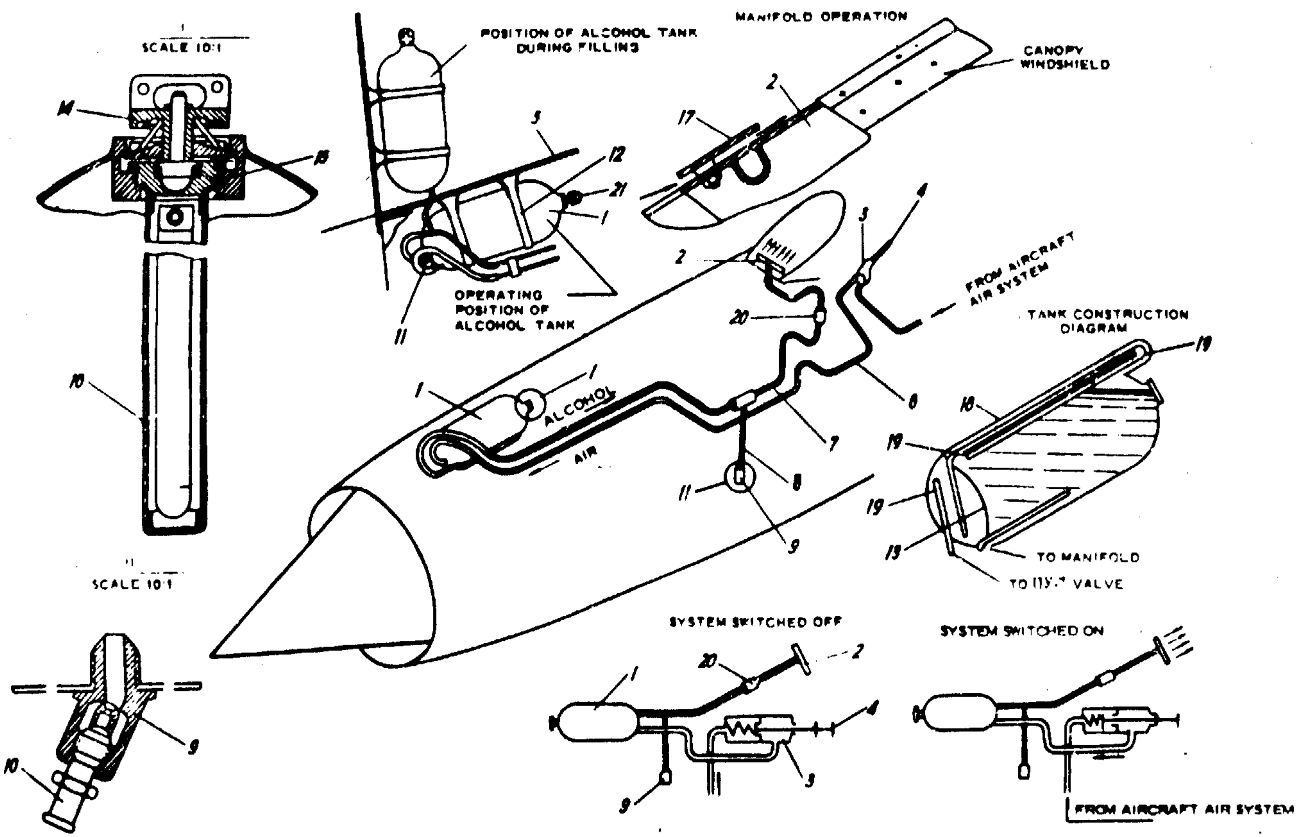

FIG.234. DE-ICING SYSTEM

1 – alcohol tank; 2 – manifold; 3 – ПУ-7 valve; 4 – switch button; 5 – access hatch cover; 6 – air connection; 7 – alcohol pipeline; 8 – drain pipe; 9 – drain connection; 10 – drain plug; 11 – rubberized fabric hose; 12 – bracing tape; 13 – partition wall; 14 – screw; 15 – cover; 16 – filter; 17 – plate; 18 – release pipe; 19 – release orifices; 20 – non-return valve; 21 – filler neck.

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When in flight, one of the above bands of the release openings must always be above the alcohol level. When being released, air escapes through these openings faster than alcohol does through the other band of openings. Once caught, alcohol sprays accumulate in a container separated from the main tank by means of separation wall 13, while air is directed through pipe 6 into the ПУ-7 valve. A repeated pressing of the button again delivers the alcohol stored up in the container to the tank and the alcohol becomes re-used.

EJECTION SEAT "CK"

1. General

Ejection seat "CK" (Fig.235) is designed to accommodate the pilot in the cockpit and secure him at different operating g-forces as well as to ensure his safe bailout at indicated airspeeds of up to 1100 km/hr in emergency. To protect the pilot from the airflow effects, use is made of the canopy movable section which is carried by the ejection seat during the bailout and covers the pilot.

The ejection seat has the following positive advantages:

(a) the pilot is protected from the airflow effects (when ejecting with the canopy used as a protective element) irrespective of the type of the pilot's outfit;

(b) braking overloads arising after the ejection seat leaves the cockpit are reduced due to an increase in the total weight of the ejected system (ejection seat, pilot, canopy);

(c) for the purpose of bailing-out, it is only a single motion that should be done by the pilot (compress the handgrips), and this can easily be done under any flight conditions;

(d) the pilot is securely held in the ejection seat due to the application of a combined harness system and actual absence of the airflow effects during the ejection;

(e) the pilot is forced to assume a position necessary for ejection because of applying a restraint mechanism;

(f) the minimum altitude required for safe ejection during flight with descending is decreased due to a shorter time needed for preparations for bailout.

The ejection seat is of a rigid structure and includes a frame with a pan, the latter carrying thereon the following operating and emergency systems:

(a) ejection seat pan control system;
(b) harness assembly;
(c) shoulder harness restraint system;
(d) firing control system;
(e) system for the seat stabilisation after ejection;
(f) leg restraint harness assembly;
(g) canopy gripping and releasing system;
(h) leg restraint locks and foot-grips system; and releasing restraint locks.
(i) emergency drive for firing mechanisms 2150 (See Fig.236) by means of three

The ejection seat is fixed in the cockpit on the rear armour plate. The rollers slide inside the pairs of rollers installed on the ejection seat rails and prevent the seat from transverse and longitudinal displacements. The ejection seat is vertically fastened by means of the ejection gun, type TCM-2500-38.

The inner cylinder of the ejection gun, type TCM-2500-38, is provided with a collar having a pair of trunnions which engage the ejection seat and get locked

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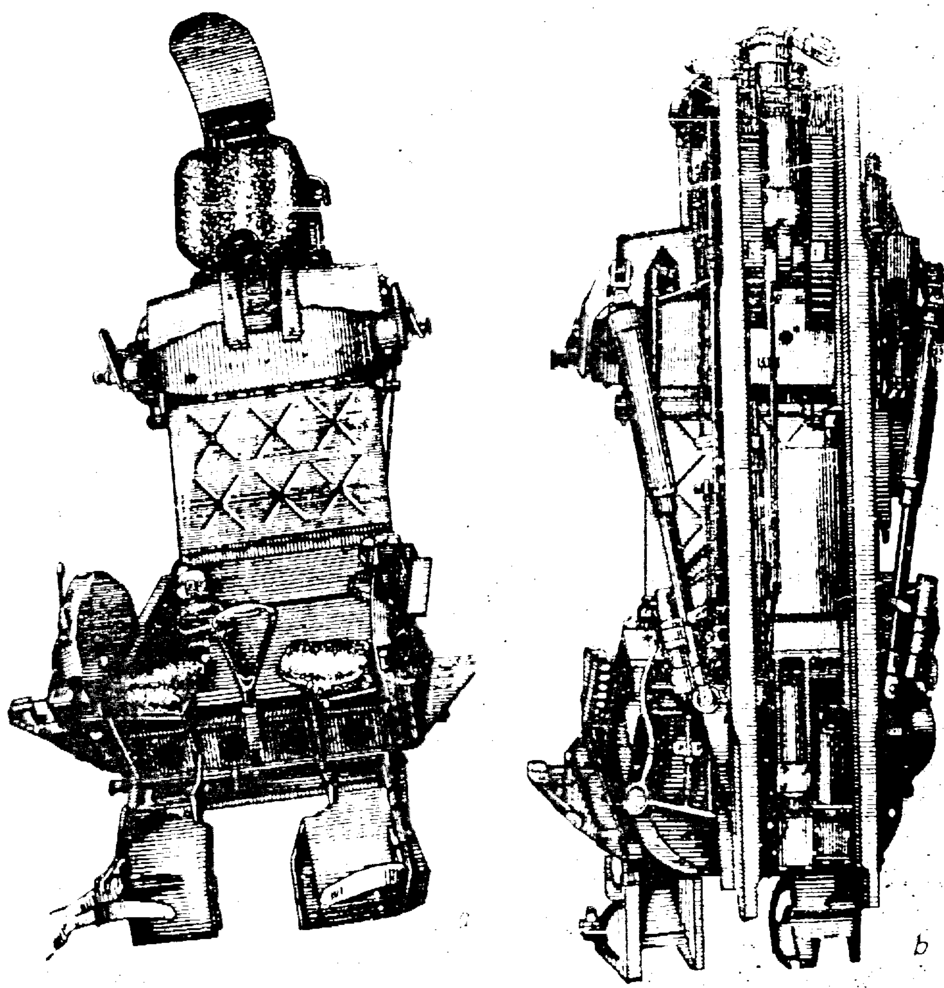
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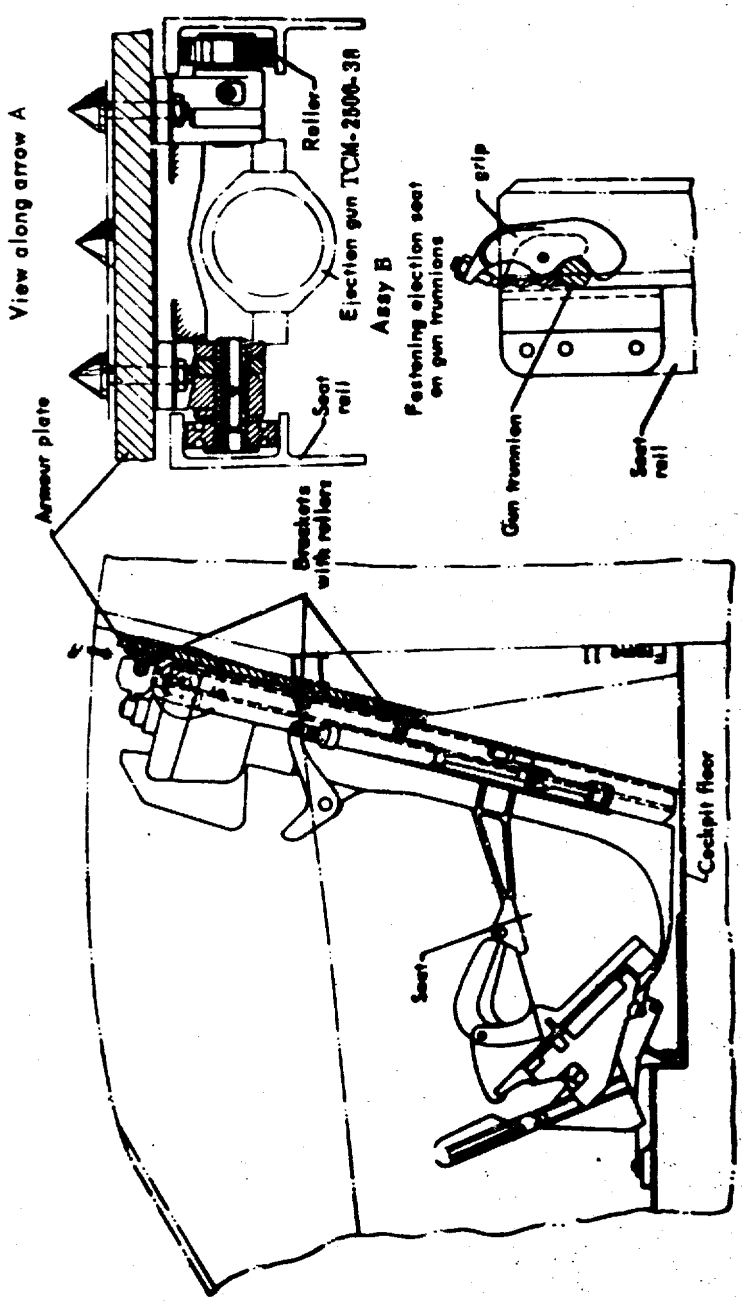

FIG.336. INSTALLATION OF EJECTION SEAT IN COCKPIT

SECRET

by two grips. The grips are pressed out and secured by screws which rest against the bracket when driven in.

When in flight, the pilot sits on his parachute placed in the ejection seat pan which can be elevated or depressed (in flight) as desired by the pilot. The ejection seat pan is electrically controlled.

The pilot is fixed on the ejection seat by means of the harness system at three points (two points at his waist and one at his shoulders). The tension of the waist belts can be adjusted by a handle mounted at the right side of the ejection seat pan.

In flight, the shoulder belt is made tight by a spring, while at ejection, by virtue of powder gases. During flight, the pilot can bend forward to 150_{-6} mm and fix himself in this position. The control of the restraint locks is effected by a handle located on the ejection seat pan left side.

Ejection can be performed both with the canopy used as a protective element and without the canopy. Ejection without the canopy is carried out only after jettisoning the canopy. The main ejection gun, type TCM-2500-38, is actuated by pressing the handgrips located on the seat pan sides.

Main Characteristics of CK Ejection Seat System

Maximum indicated airspeed, at which safety ejection is ensured	1100 km/hr
Ejection overloads Пy	from 15 to 18
Braking overloads Пx at an indicated airspeed of 1100 km/hr	from 35 to 36
Minimum safety altitude for ejection during level flight	110 m.
Total rated weight of ejected system	240 kg
Weight of ejection seat with ejection gun inner tube	83 kg
Weight of canopy movable section	57 kg
Weight of pilot with parachute and with complete outfit on	100 kg
Cartridges applied:	
for TCM-2500-38	ПК-16
for firing mechanisms 215П, 215Ф; 215P	ПК-3М-1
Parachute with a capron harness system	C-3

The construction of the ejection gun, type TCM-2500-38, and firing mechanisms, types 215Ф, 215П, and 215P, is given in detail in Book 2 of the present Manual.

2. Ejection with Canopy Used for Pilot's Protection

(See Fig.237)

Upon decision of catapulting himself, the pilot will press the release levers of seat handgrips 1 a. This done, the restraint mechanism 215P of the harness system is set in operation. The mechanism draws the pilot to the seat backrest and fixes him by lock 1б, after which the TCM-2500-38 1в fires and the seat starts moving upward.

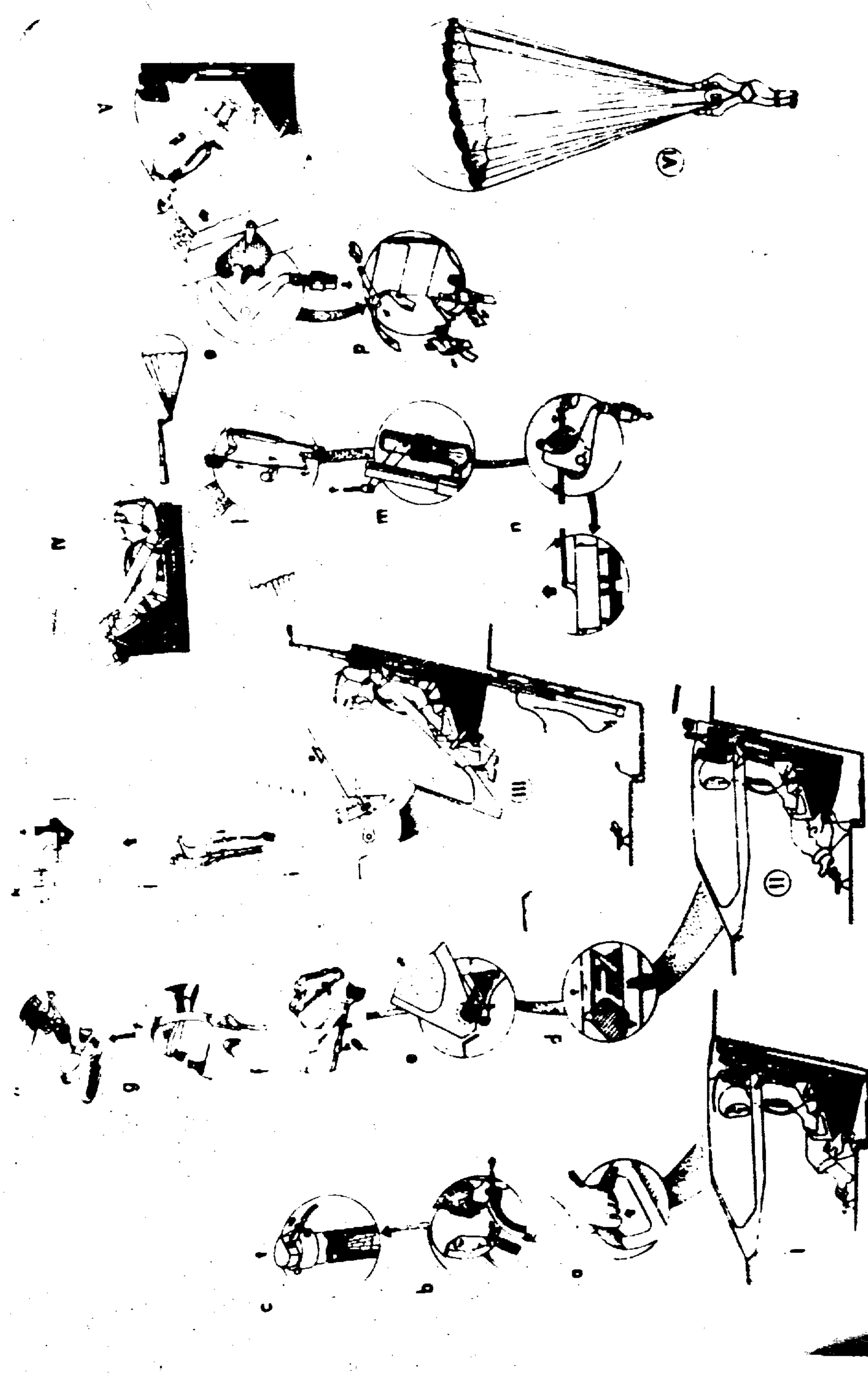

FIG.237. EJECTION WITH CANOPY USED FOR PROTECTION

As the seat travels 16 or 22 mm, the seat trunnion pins enter the rear grip locks of the canopy, are fixed by these locks and release the emergency locks (II d). The canopy starts moving upward together with the seat. The canopy front section is retained by the time delay lock from lifting upward (II e).

The moment the seat has travelled 30 to 50 mm, the cotter pin of the 215П firing mechanism is pulled out, the pin being connected to the fuselage by means of a cable. The 215П firing mechanism operates and knocks out the canopy hole cover, exposing the drogue parachute to the airstream. The parachute canopy gets inflated with air before the seat leaves the guide rollers (III).

After the seat has travelled a distance of 530 ±10 mm, hinge supports for the canopy assume their respective positions (II f). The control pedal belts fastened by a calibrated spring clamp separate (II g), the pilot's feet go down to rest on the foot rests and are automatically fixed thereon by foot-grips (II h).

When the ejection seat takes such a position relative to the airstream that it is pressed to the fuselage, the time delay lock gets open and the cockpit canopy lies with its rollers onto the transparent shield and rolls over it (III i).

The АД-3У time release mechanism cotter pin connected by a halyard to the fuselage structure is pulled out and actuates the АД-3У time release mechanism (III j).

The front grip locks are laid on the hinge supports of the ejection seat and get locked therein (III k). The ejection seat leaves the rollers and flies over the aircraft fin after having separated along with the inner tube from the TCM-2500-38 ejection gun.

1.5 seconds after the ejection has been already started, the АД-3У time release mechanism is set in operation and actuated the 215Ф firing mechanisms which release the canopy front grip locks (IV n) and the drogue parachute rod lock. The rod (the 215П firing mechanism in the extended position) with the drogue parachute is separated from the ejection seat (IV).

The firing mechanisms 215Ф turn the cockpit canopy with respect to the seat trunnion pins and release the locks of the pilot's harness system. Further, the cockpit canopy keeps on turning by inertia and due to the effects of the airstream. As soon as the cockpit canopy turns approximately through 110° to 120°, the rear grip locks get open and the cockpit canopy leaves the ejection seat (V).

The cockpit canopy ejected from the seat, the pilot readily leaves the ejection seat.

When the pilot starts leaving the seat, the КАП-3 automatic time release mechanism is set in operation, the mechanism being placed in the parachute pack. When ejection is made at a high altitude, the pilot performs a delay opening jump. Then, the КАП-3 automatic time release mechanism is actuated to open up the parachute pack and extract the parachute used by the pilot to safely reach the ground surface (VI).

Ejection without Canopy Protection

Ejection with no canopy applied as a protective element is allowed at an indicated airspeed of up to 700 km/hr. For this purpose, it is necessary to first jettison the cockpit canopy. In this case all the operations are performed in the same sequence as described above except those of the retention and subsequent separation of the canopy.

3. Ejection Seat Frame

(Fig.238)

The ejection seat frame is a rigid assembly composed of two vertical steel sections - rails 3 and two cast transverse electron beams: lower and upper ones 5.

Attached to the rails by means of guides 6 is seat pan 7 accommodating the parachute pack. The lower beam also serves as the body of the reducer of the ejection seat pan control system. Above the upper beam, there is armour headrest 4 with a soft pad made of porous plastics. It carries guard plate 1 protecting the pilot's head. Upon ejection when the canopy separates from the ejection seat, the canopy glass is sliding over this plate. To protect the glass from scratching by plate 1, protective cover 2 made of artificial chamois leather is glued onto the plate. The canopy glass at the point it contacts with plate 1 is coated with a protective glue film.

Mounted at the ends of the ejection seat rails is protecting yoke 8 which serves to facilitate the seat sliding when jettisoned, i.e., the protecting yoke permits the foot-rests to get clear of the TCM-2500-38 ejection gun tube.

The protecting yoke is set in the operating position (when the ejection seat moves upward) under the action of inertia forces and due to the effort applied by a pair of springs 12 installed on the yoke axles of rotation. The yoke is retained from snapping back by safety pins 11 extended by flat springs 9 enclosed in the box-shaped ends.

The protecting yoke turn through approx. 73° is limited by means of flat shackles 10 secured to the pins of the yoke and ejection seat rails.

In the operating position (extreme upper position), the protecting yoke is pressed to the cockpit false floor by springs 12. In order to set the protecting yoke in the operating position when the ejection seat is installed into the cockpit, the fixing pins must be sunk into the yoke recesses by the fingers of the hand, while the yoke proper should be lifted to take the upper position and fastened to the ejection seat pan (through hollow rivets) by special halyard 13 attached to the halyard of the seat ground stopper system. The halyard carries a flag having the inscription: HALYARD TO SECURE YOKE TO EJECTION SEAT PAN WHEN INSTALLING IN COCKPIT. The seat installed in the cockpit, the halyard should be detached and pulled out from under the ejection seat pan.

4. Ejection Seat Pan Control System

(Fig.239)

To improve the conditions of piloting, visibility at landing and watching of the instrument panel, the pilot may change the position of the seat pan by lifting or lowering it according to his height. The maximum travel of the seat pan amounts to 80^{+10} mm.

The seat pan is lowered and raised by means of electric motor 8 which aided by a reduction gear rotates vertical screw 6 passing through nut 7 dead-fixed onto the seat pan. Electric motor 8 and screw 6 are installed on the seat frame lower transverse beam which simultaneously serves as the body of the reduction gear. The reduction gear consists of two worm and wheel pairs having a ratio of 1:144. The 0.18 kW, 9500 r.p.m. reversible electric motor, type МУ-100АП, uses the current furnished by the aircraft electric mains. The electric motor is cut in by a switch mounted on the cockpit port side.

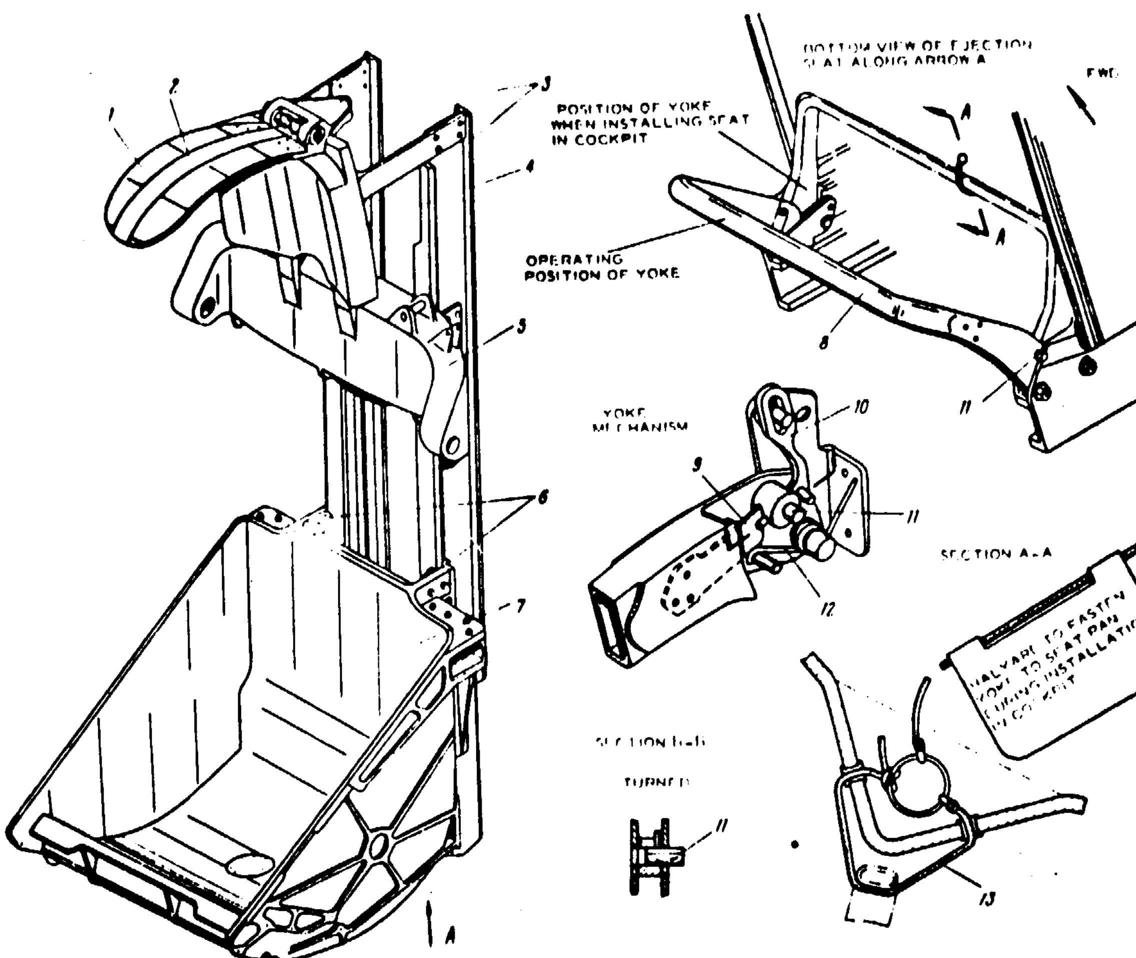

FIG.238. EJECTION SEAT FRAME.

1 – guard plate; 2 – packing; 3 – vertical section; 4 – plate; 5 – upper beam; 6 – guiding cups (guides); 7 – seat pan; 8 – protecting yoke; 9 – spring; 10 – shackle; 11 – locking pin; 12 – spring; 13 – halyard.

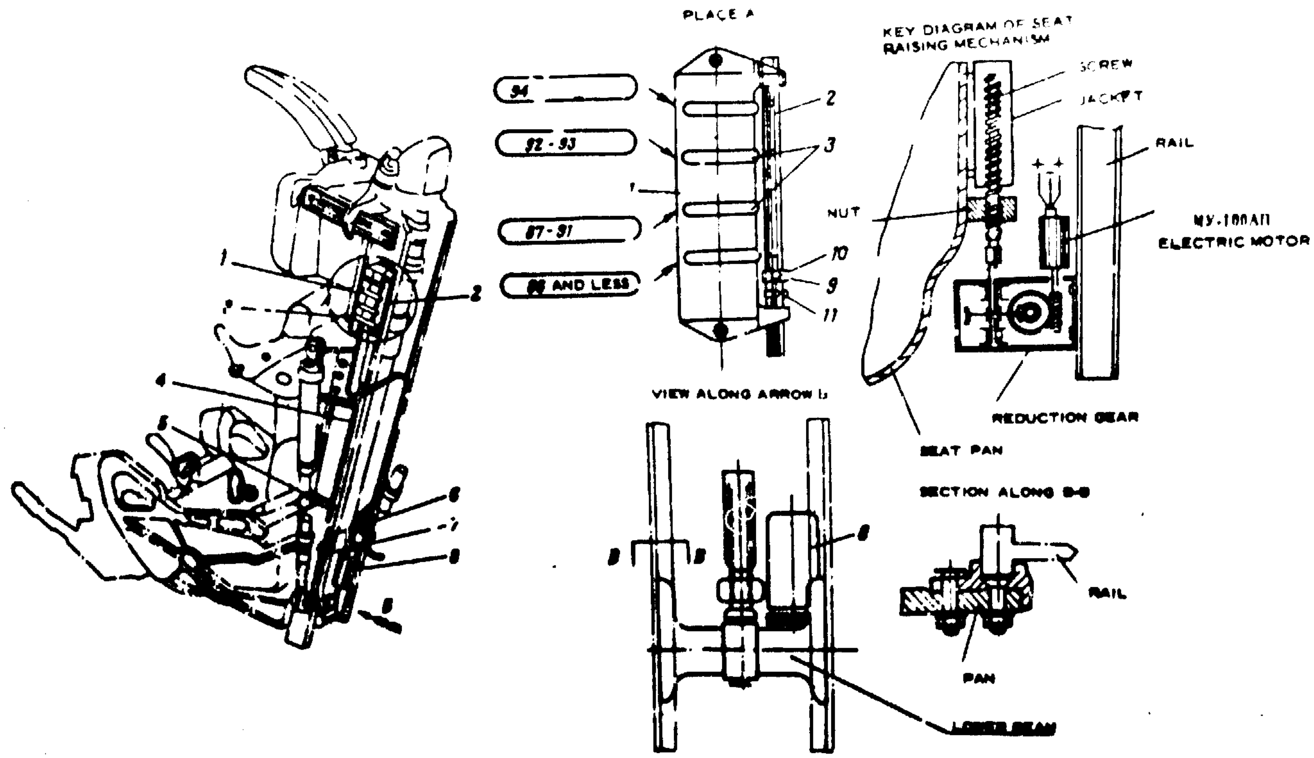

FIG.239. EJECTION SEAT PAN CONTROL SYSTEM

1 – seat pan level adjusting mechanism; 2 – control rod; 3 – pointer; 4 – rod; 5 – bracket; 6 – screw; 7 – nut; 8 – electric motor; 9 – upper collar; 10 – screw; 11 – lower collar.

It takes the seat pan 26 sec. to travel from the lower position to the upper one.

In order to disconnect the electrical wiring when the seat is removed or bailout is made, there is an electric connector, type ШР20-ПК4ВШ8, installed on the right-hand rail, below.

The seat pan is fixed in its extreme positions by seat pan travel control mechanism 1 mounted on the left-hand rail in the vicinity of the headrest. Seat pan travel control mechanism 1 also makes it possible to adjust the seat pan travel in accordance with the pilot's height.

The ejection seat should be adjusted according to the pilot's height so that the minimum clearance between the canopy glass and the pressurized helmet shall be about 50 mm (with the parachute pack being about 200 mm thick less the КП-27 mechanism) when the ejection seat pan is set in its extreme upper position whatever the pilot's height be.

Seat travel control mechanism 1 is a body housing two limit switches and control rod 2 linked through additional rod 4 with the seat pan. Control rod 2 carries rings to press the switches. Upper ring 9 is made movable and secured by screw 10; it controls the upper switch and fixes the seat pan in its upper position. Lower ring 11 is made fixed and controls the lower switch, fixing the seat pan in its lower position.

The amount of the ejection seat pan travel is determined by the distance between the rings and the switches. With the seat pan in its lower position, its travel equals the distance between the upper ring and the upper switch. With increased distance between the rings, the seat pan travel is reduced. With the seat pan set in its extreme position when the rod is extended to such an extent that both rings simultaneously press both the switches (in case the pilot is of a maximum permissible height), the ejection seat pan gets beyond any control.

The mechanism is provided with pointers 3 indicating maximum permissible heights of pilots in their sitting position, which makes it possible to adjust the seat for any pilot beforehand.

The seat is adjusted according to the pilot's height in the following manner. The ejection seat pan is moved to take its extreme lower position. This done, upper ring 9 is set opposite to the pointer indicating the pilot's height. In this position, the ring is fixed by locking screw 10.

In case the height of the pilot in his sitting position measures 94 cm., the seat pan adjustment is impossible, since in the case the above clearance of 50 mm is provided only with the seat pan set in its extreme lower position.

5. Harness System

(Fig.240)

The pilot should be secured during the ejection as well as in flight when the inertia forces acting on the pilot are directed forward, to the sides or upward. These effects occur at diving, abrupt braking, during flight in bumpy air, at spinning, etc.

The forces pushing the pilot off the seat in the forward direction may be particularly large in case the aircraft makes an emergency landing outside the airfield.

The pilot is secured to his seat by means of the C-3 harness system of the standard personnel parachute or improved harness system, type ППС-161.

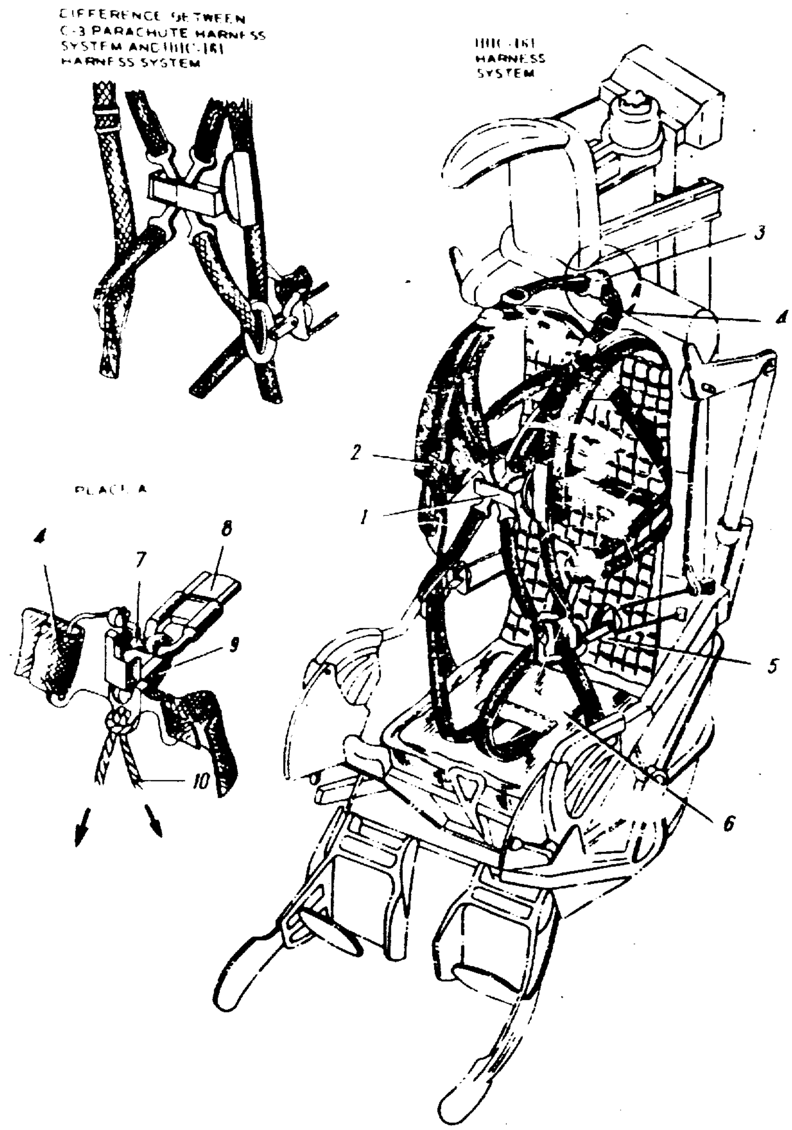

FIG.240. HARNESS SYSTEM
1 – central lock; 2 – shoulder belt lock; 3 – back belt lock; 4 – shoulder belt; 5 – pulley; 6 – parachute; 7 – lock; 8 – strap; 9 – hook with buckle; 10 – damping cord

SECRET

The harness system is connected to the ejection seat at three points, namely: at two points at the pilot's waist and singly at his shoulders. The harness system is fastened at the pilot's shoulders by means of special strap 8 and shoulder belts 4.

One end of strap 8 is fixed in the shoulder restraint lock, while its other end is secured in lock 3 of the shoulder belt. Lock 3 is essentially hook 9 with a buckle with belts 4 passed through. Fitted over the hook is a tip of strap 8 which is then locked by latch 7.

To prevent lock 3 from striking the pilot's head when at ejection after the pilot's separation from the seat, the lock is drawn downward by means of shock-absorbing cord 10.

The harness system is fastened at the pilot's waist through the leg straps by means of pulleys 5. The leg retaining straps are preliminarily passed through side buckles and then fixed in central lock 1.

The harness system is put on the pilot in the cockpit. For convenience in putting on the harness system, type ППС-161, the latter is provided with lock 2 mounted on the right-side shoulder strap.

Harness Restraint System

(Fig.241)

To provide more convenience in controlling the aircraft and render more reliable the pilot's fastening under the action of appreciable g-forces, and particularly those due to the ejection, the seat is fitted with a restraint system. It incorporates shoulder and waist belts restraint mechanisms.

Shoulder Restraint Belt Mechanism

The shoulder restraint belt mechanism operates both under normal flight conditions and at ejection. When in normal flight, the shoulder restraint mechanism fixes the pilot's shoulders in two positions: (a) when the pilot is drawn to the seat or (b) when he bends forward by 150_{-6} mm. In the first position, the pilot is constantly drawn to the seat by spring 17, while in the other position, the spring exerts no action on the pilot. When at ejection, if the pilot is in an inclined position, he is positively drawn to the seat backrest and is fixed as such.

The shoulder restraint mechanism comprises: shoulder restraint lock 11 with strap 14; firing mechanism, type 215P, with actuating spring 17; inclined position locking mechanism 20; shoulder restraint mechanism handle 23, and cable linkage 7.

The shoulder restraint system operates as follows. In the drawn position, the pilot's shoulders are retained from moving forward by lock 11. In order to release his shoulders, the pilot should pull shoulder restraint mechanism handle 23. Reel 9 gets released. Then it is necessary to pull strap 14 as far as it will go, overcoming the stress of spring 17; in this case reel 9 rotates and winds cable 13 onto roller 10. The 215P firing mechanism is compressed and rod 19 moves upward. Handle 23 released during the backward movement of the shoulders, rod 19 moves downward and is stopped there by mechanism 20, fixing the pilot in the inclined position. For unlocking it is necessary to pull backward handle 23 again. Mechanism 20 will release rod 19, the 215P firing mechanism, due to the spring action, gets extended and draws the pilot's shoulders to the ejection seat backrest.

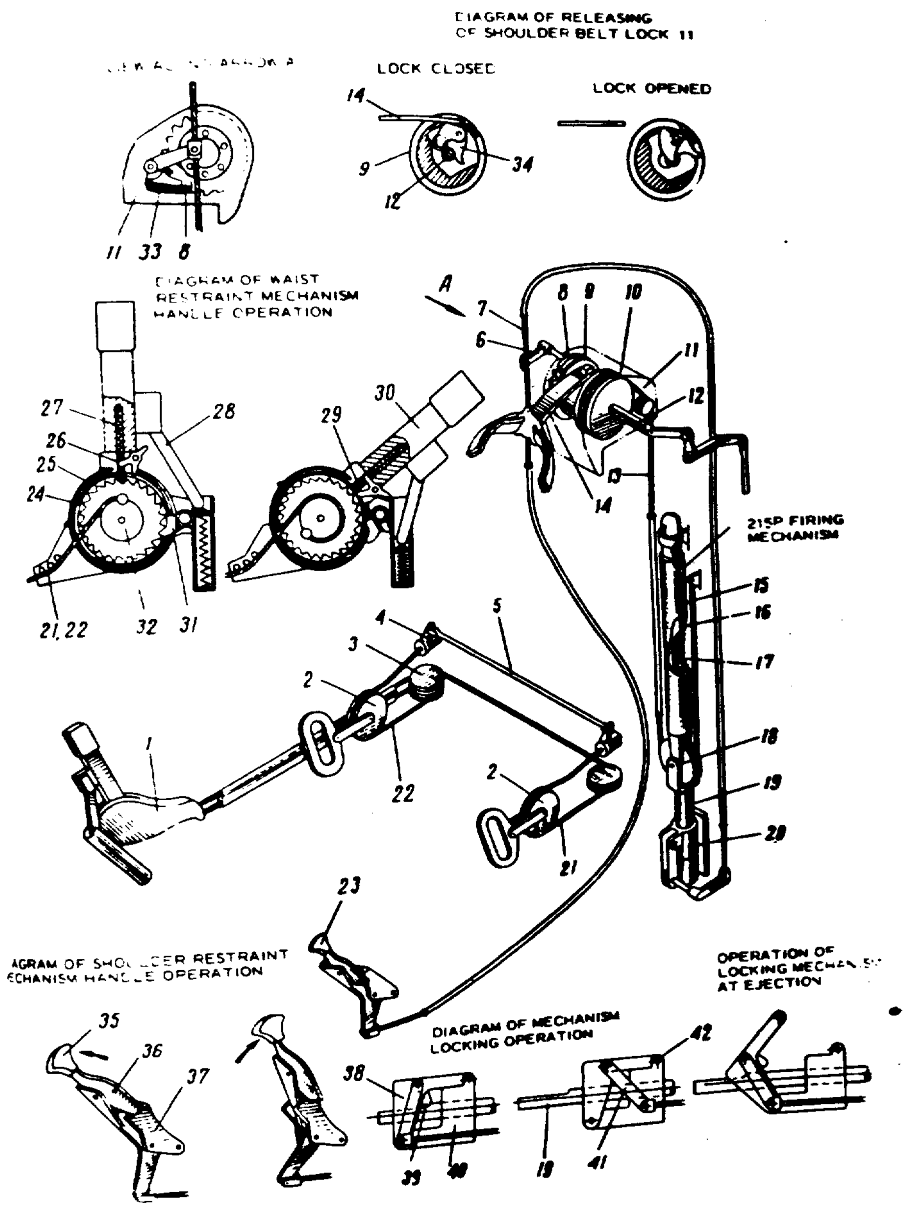

FIG.241. HARNESS RESTRAINT SYSTEM

1 – waist belt restraint mechanism handle; 2 – pulley with buckle; 3 – guide roller; 4 – waist belt restraint lock; 5 – rod; 6 – bell-crank; 7 – cable; 8 – ratchet; 9 – reel; 10 – roller; 11 – shoulder belt restraint lock; 12 – locking rod; 13 – restraint cable; 14 – stop; 15 – 215P firing mechanism outer tube; 16 – 215P firing mechanism inner tube; 17 – spring; 18 – roller; 19 – rod; 20 – inclined position locking mechanism; 21,22 – waist belt restraint cable; 23 – shoulder belt restraint mechanism handle; 24 – handle ring; 25 – body ring; 26, 31, 33 – pawls; 27 – spring; 28 – pusher; 29 – stop; 30 – handle; 32 – roller; 34 – hinge stop; 35 – stop lever; 36 – bell-crank; 37 – bracket; 38 – hinge piece; 39 – stop; 40 – bracket; 41 – bell-crank; 42 – shear screw.

Handle 23 released, reel 9 becomes locked, and the pilot is fixed in the drawn position.

The shoulder restraint mechanism lock is reel 9 with ratchet 8 rigidly fastened to one of the reel faces. Pawl 33 locks the reel and retains it from turning when strap 14 is being tightened. The other face of the reel is provided with roller 10 having cable 13 secured therein.

Strap 14 is fastened to the reel by hinge support 34 which is fixed in the operating position by rod 12. Rod 12 being pulled out, support 34 moves inside the reel and releases the strap.

Cable 13 runs over roller 18 of the 215P firing mechanism and is fastened to the seat frame.

The 215P firing mechanism consists of two tubes: inner tube 16 and outer tube 15. The inner tube is dead-fixed to the seat left-hand rail. The outer tube is free to slide along the inner one and, due to the action of spring 17 with the help of roller 18 secured on the tube bottom, tightens cable 13.

Locking mechanism 20 is constructed as follows. The mechanism body is made of two pieces: fixed bracket 40 and hinge piece 38 which is hinged to the bracket and secured by shear screw 42. Travelling inside the body is rod 19 linked with the outer tube of the 215P firing mechanism. Mounted on hinge piece 38 are swivelling stop 39 and bell-crank 41 attached to a common shaft. Bell-crank 41 is connected to handle 23 by the cable linkage. When rod 19 travels upward, stop 39 is turned by the spring and locks the rod in its upper position.

If the pilot catapults from his inclined position, the firing mechanism 215P gets extended due to the action of the spring and powder gases. Rod 19 pushes stop 39, cuts off shear screw 42 and turns the hinge piece of the body, slipping down. As a result, the pilot is drawn to the seat backrest.

Handle 23 is made like bell-crank 36 hinged to the seat pan by means of bracket 37. One arm of bell-crank 36 is fitted with stop lever 35, while the other is connected to pawl 33 and stop 39 through the cable linkage.

In order to operate the handle, it needs be unlocked by pressing the upper end of the stop lever to the seat pan and then be pulled backward.

Waist Belt Restraint Mechanism

The waist belt restraint mechanism makes it possible to adjust the degree of the pilot's freedom with respect to the seat.

The mechanism incorporates: waist restraint mechanism handle 1, two pulleys with buckles 2 fitted to the harness system, two waist belt restraint mechanism locks 4 securing therein the ends of cables (21 and 22), and elements of a cable linkage, i.e. guide rollers 3, etc.

The waist belt restraint cable can be added in its tension by swinging movements of handle 30.

To slacken the cable, it is necessary to move handle 30 forward as far as it will go and then cable 21 may be drawn out.

Waist belt restraint mechanism handle 1 is housed in body 25 which is fastened to the right side of the seat pan. The body accommodates two-groove roller 32 having a ratchet and cables 21 and 22 embedded therein.

Spring-loaded pawl 31 which locks roller 32 enters the body from above. Ring 24 of handle 30 is fitted to a ring of body 25 and can be turned forward. Mounted inside the handle is stop 29 loaded by spring 27. The stop engages the ratchet teeth. By means of pawl 26, the stop can be pressed upward. In this case, the handle will rotate without turning the ratchet wheel.

When handle 30 moves forward, roller 32 turns and winds up the cables, thus increasing the restraining action exerted on the pilot. When the handle moves backward, pawl 31 locks roller 32, the ratchet teeth press off stop 29 and the handle turns with respect to the roller.

When the handle is pushed forward as far as it will go, the ring jumper of handle 24 rests against pawl 31 and presses it off. Simultaneously, pawl 26 rides on the ring jumper of body 25, turns and presses stop 29 upward. As a result, roller 32 can freely rotate and cables 21 and 22 can readily be pulled out.

If it is impossible to move handle 30 forward because of an excessive tension of cables 21 and 22, disengage stop 29 from the ratchet by pressing pawl 26 by hand; this done, handle 30 will be freely moved forward.

To automatically return handle 30 to its initial position, the body is fitted with a special spring which makes it possible to shift the handle backward by means of pusher 28.

The description of the waist belt restraint mechanism locks is presented in Section "Restraint Lock and Foot-Grip Release System".

6. Control System of TCM-2500-38 Ejection Gun

(Fig.242)

The TCM-2500-38 ejection gun is actuated by pulling out cotter pin 4 cabled to handgrips 1 of the seat. To fire the mechanism, it is necessary to compress one or both of the handgrips at a time.

The seat handgrip (Fig.243) is constructed as follows. Hinged to body 7 are release lever 4, safety lever 2 and protecting yoke 3. The firing control wiring is connected to release lever 4. In normal position, the release lever is prevented from an accidental operation by means of bolt 5 which with its head enters the safety lever hole. When only the release lever is pressed, the bolt head rests against pawl 1 and locks the release lever. When only the safety lever is actuated, plate 6 rests against the head of bolt 5 and locks the safety lever. The ejection gun can be fired only when both the release and locking levers are pressed at a time. The release and locking levers are checked for proper locking by the alignment of white notches made on the handgrips.

In this position bolt 5 moves upward and leaves the safety lever hole.

Protecting yoke 3 covers the slot between the release and safety levers and protects the handle from being jammed when the handgrip is compressed.

From the release levers of the handgrips, the cable linkage (See Fig.242) runs to common shaft 9 with sectors 2 and from the right sector of the shaft runs to release lever 6 of the 215P firing mechanism. From lever 6, the cable linkage by means of shackle 7 with a hole, rod 5 and a cable is connected to cotter pin 4 of the ejection gun.

When the handgrips are compressed, the 215P firing mechanism operates first and the pilot is drawn backward to the seat.

Then, lever 6 having travelled inside the hole of shackle 7 pulls out cotter pin 4.

The TCM-2500-38 is set into operation.

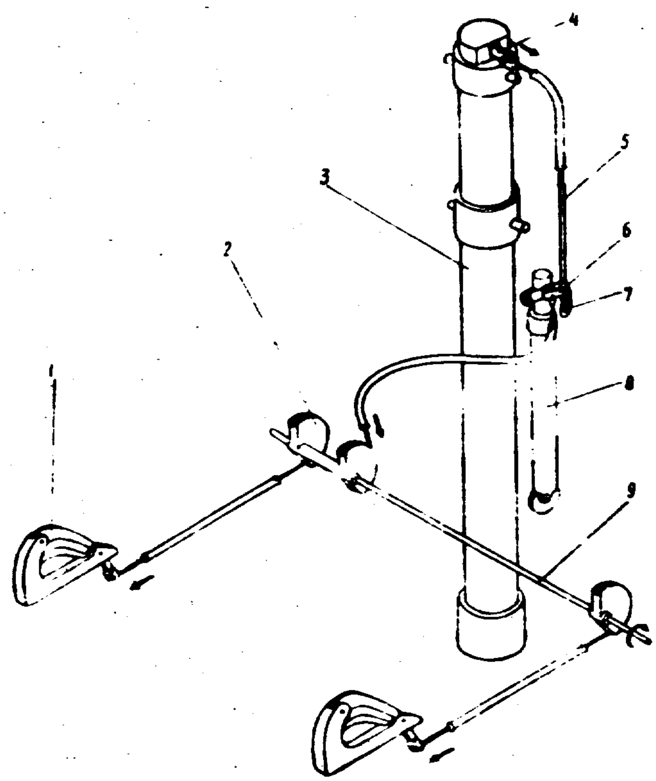

FIG 242. CONTROL SYSTEM OF TCM-2500-38 EJECTION GUN
1 – handgrip; 2 – sector; 3 – TCM-2500-38 ejection gun;
4 – cotter pin; 5 – rod; 6 – 215P firing mechanism release lever;
7 – shackle; 8 – 215P firing mechanism; 9 – shaft.

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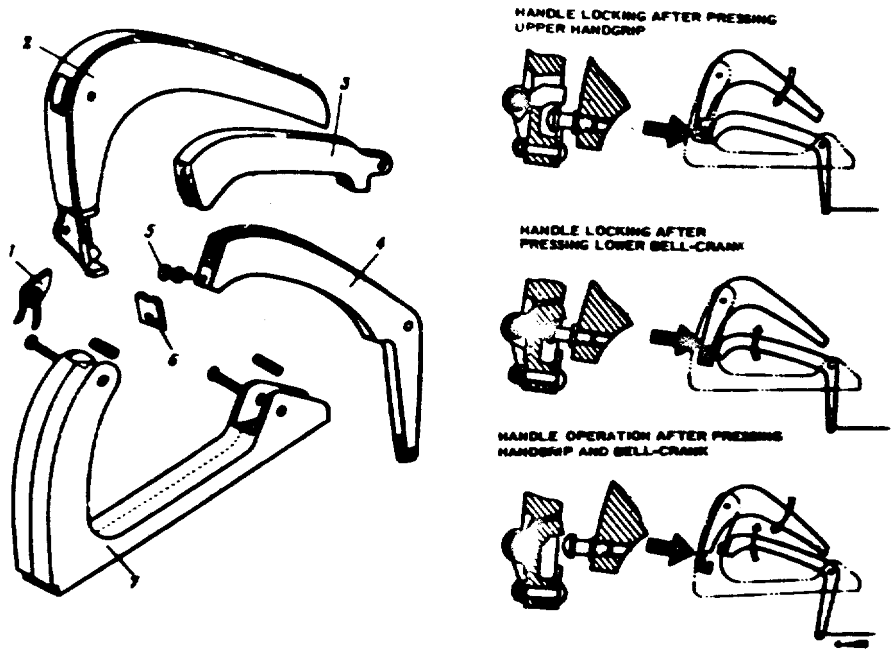

FIG.243. HANDGRIP CONSTRUCTION AND OPERATION
1 – pawl; 2 – safety lever; 3 – protecting yoke; 4 – release lever; 5 – bolt; 6 – plate; 7 – body.

7. Ejection Seat Stabilizing System

(Fig.244)

To prevent the ejection seat from undue turning forward after ejection, the seat is fitted with rotating drogue parachute 1 with the canopy area of 0.15 m^2.

The parachute shroud lines fitted to the thimble are fastened to the head of the 215П firing mechanism by means of adapter 2.

When in flight, the parachute packed in fabric container 3 is located above the head of the TCM-2500-38 ejection gun. The shroud lines packed in special case 4 are placed into the headrest right-hand pocket where the case is fastened to yoke 5 by means of a snap hook.

In order to provide for reliable deployment of the drogue parachute before the seat leaves the rollers, the parachute is exposed to the airstream in the container at the very beginning of the ejection with the aid of the 215П firing mechanism whose cotter pin 6 is connected by cable 7 to the aircraft structure and is pulled out after the seat has travelled 30 to 50 mm.

When extending, the firing mechanism knocks out the access hole door on the canopy rear arch, pulls the shroud lines from the case and exposes the container with the drogue parachute to the airstream. The drogue parachute container is attached to the head of the 215П firing mechanism by means of special yoke 8 and two studs 9 cable-connected to the seat frame. After the 215П travels of 200 mm, the cables become tightened and pull out studs 9. The airstream tears the container off the drogue parachute, the parachute canopy gets inflated with air and starts rotating.

Adapter 2 is a radial thrust bearing and consists of shaft 11 carrying fork 10 and holders 12 accommodating lug 13. Shaft 11 rotates inside holder 12 on rollers.

1.5 sec. after the ejection, immediately before the cockpit canopy separates, the rod of the 215П firing mechanism is thrown off together with the drogue parachute.

For this purpose, the upper part of the outer tube of the firing mechanism is made split and is fastened by means of collar 14 consisting of three members.

Collar 14 is locked on the tube by yoke 15 hinged to the seat frame. Connected to yoke 15 is fork 16 linked through rods and bell-cranks to levers 17 for the canopy separation. When levers 17 turn, yoke 15 releases the collar which, being acted upon by the load of the drogue parachute, gets open and the upper part of the outer tube together with the inner tube, piston and the drogue parachute separates from the ejection seat.

8. Foot-Grip System

(Fig.245)

The purpose of the foot-grip system is to prevent the pilot's legs from an excessive separation due to inertia forces during the ejection. The system is mounted on the foot-rests and is automatically actuated the instant the pilot abruptly places his feet upon the foot-rests. The system incorporates foot-grip 1 and lever 2 linked to each other by rod 13. At ejection, the pilot presses levers 2 with his feet, turns the levers, foot-grips 1 retaining the feet on the foot-rests. The system is held closed by retainer 12 with the aid of a toothed sector attached to lever 2.

The foot-grips can be opened after the ejection by hinged retainer 12. In the operating position, the hinged retainer is kept by lever 10 whose other end rests against bell-crank 8. Both bell-cranks 8 are mounted on shaft 6. Rod 5 links

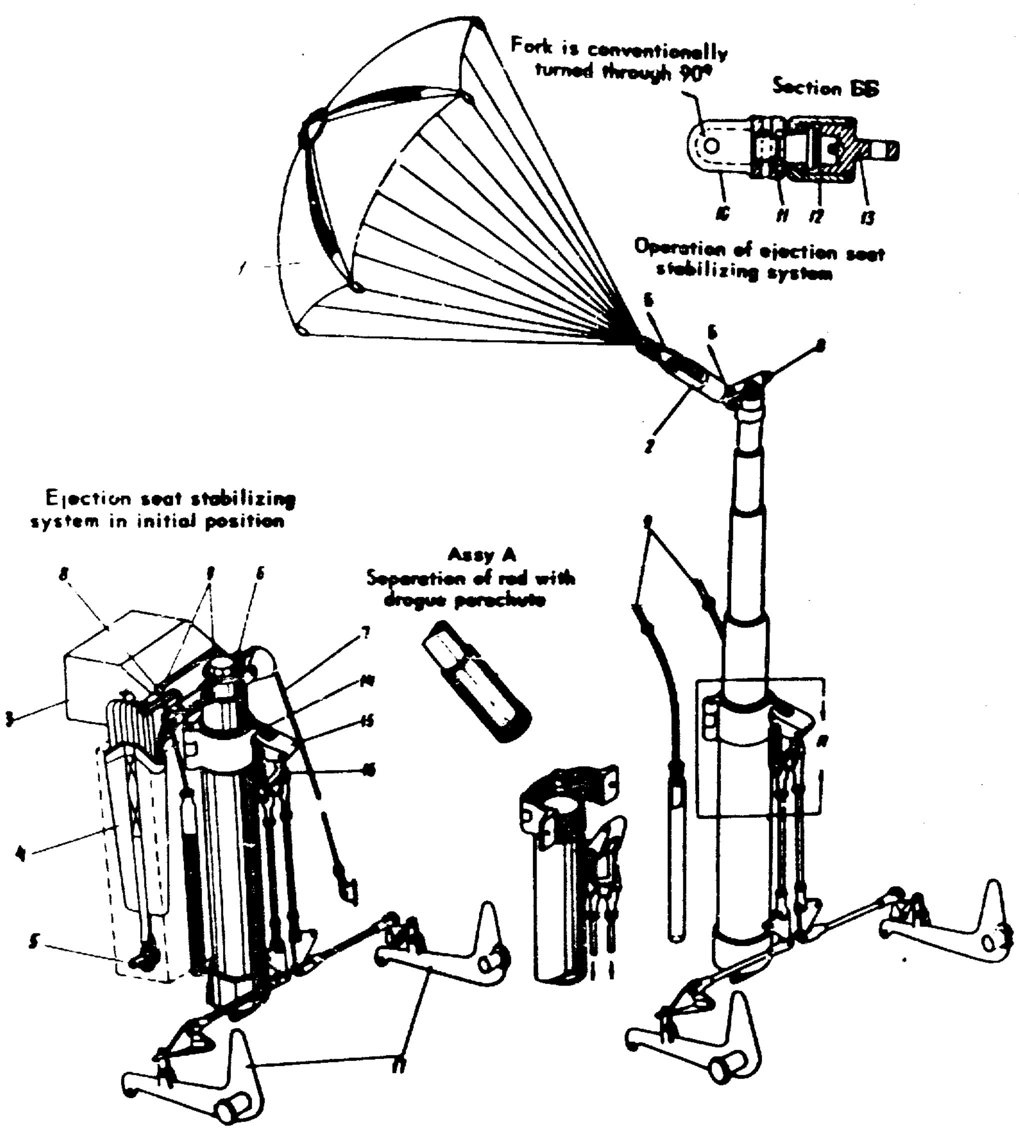

FIG.244. EJECTION SEAT STABILIZING SYSTEM

1 – drogue parachute; 2 – rod. post; 3 – parachute bracket; 4 – parachute shroud lines case; 5 – yoke; 6 – 215П firing mechanism cotter pin; 7 – cable; 8 – yoke; 9 – stud; 10 – fork; 11 – shaft; 12 – holder; 13 – eyebolt; 14 – collar; 15 – yoke; 16 – fork; 17 – canopy separation levers.

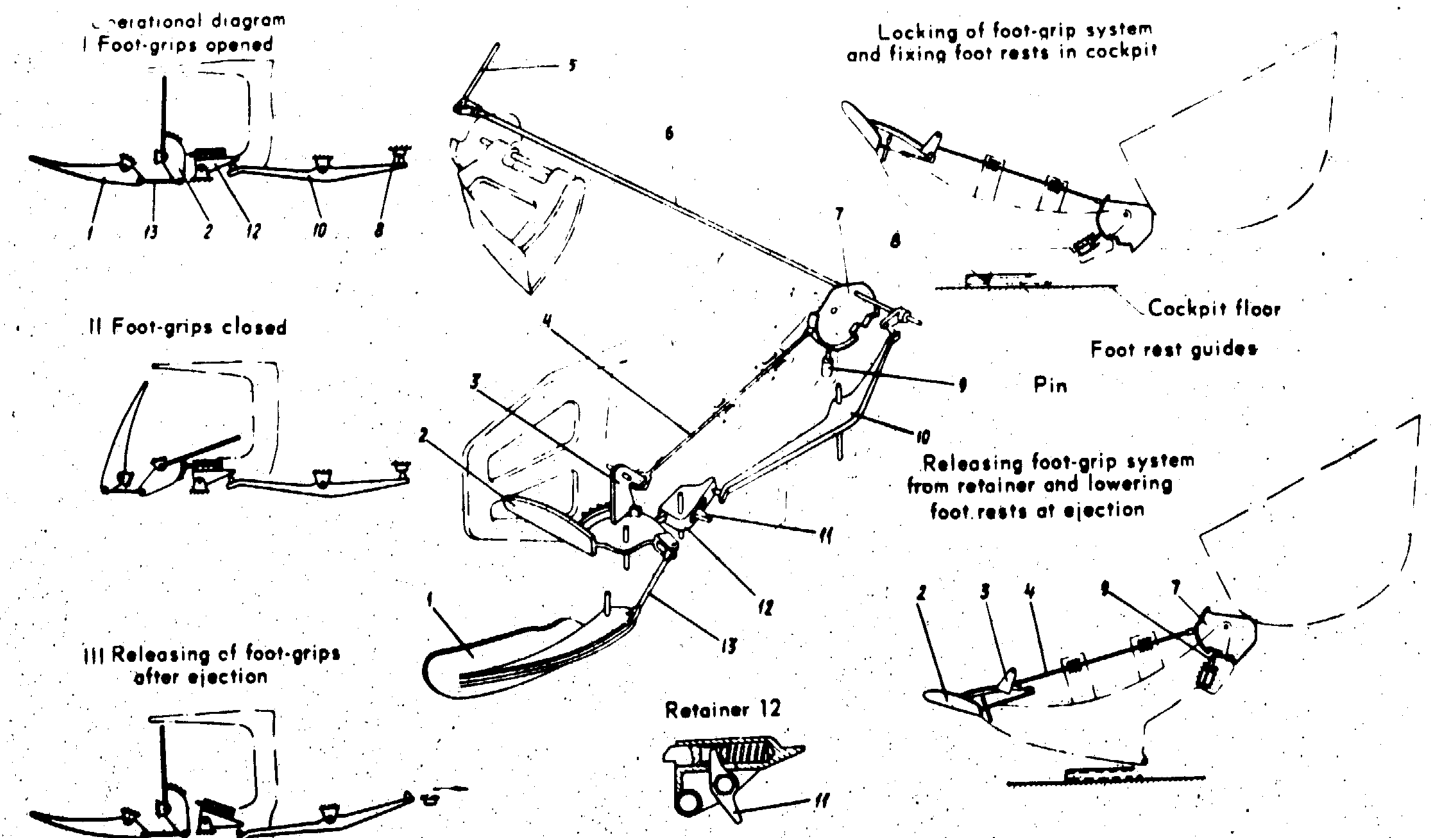

FIG.245. FOOT-GRIP SYSTEM
1 — grip; 2 — lever; 3 — retainer; 4 — pusher; 5 — rod; 6 — shaft; 7 — shaped sector; 8 — bell-crank; 9 — retainer; 10 — lever; 11 — pawl; 12 — retainer; 13 — rod.

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hem with the system releasing the restraint and foot-grip locks. On turning bell-crank 8, lever 10 releases retainer 12 and the foot-grips get open.

To prevent the foot-grips from an accidental closing when the seat is installed in the cockpit, special retainer 3 is provided which enters the slot of the toothed sector and prevents lever 2 from turning. Retainer 3 is controlled by pusher 4 whose other end rests against shaped sector 7 installed on the axle of rotation of the foot-rest.

When in use, in case the seat has already been installed in the cockpit, the foot-rests are elevated. In this case, the end of pusher 4 rests against the recess of sector 7 and retainer 3 fixes lever 2 in the open position. At ejection, the foot-rests move down under the action of pins sliding inside the foot-rest guides installed in the cockpit floor. Pusher 4 is pressed off by the projection of sector 7 and forces retainer 3 to leave the toothed sector slot.

In the lowered position, the foot-rests are fixed by retainer 9. In case the foot-grips are accidentally closed, they can be opened by pressing off the dowel pin of retainer 12 with the aid of pawl 11.

9. Cockpit Canopy Holding and Separation System

(Fig.246)

During ejection, the cockpit canopy is gripped and held by means of trunnions 3 and hinge supports 7 of the seat.

Supports 7 are rigid brackets hinged to the seat pan.

In the upper parts of the supports there are cut-outs to receive the inserts of the front grip locks as soon as the canopy is gripped.

The inserts strike support 23 and turn it down, shearing screw 25 and releasing spring-loaded pin 24 which comes out and locks the insert.

Under normal operating conditions, the supports are pressed to the seat pan and retained with the help of stops 13 mounted on shaft 12.

Shaft 12 via bell-crank 8 is connected to the cockpit floor by cable 9. When the seat moves, cable 9 is pulled out of tube 11. After the seat travels approximately 530 $\pm$10 mm and the supports are in line with the canopy-carrying panel, the cable end with the bush pressed thereonto rests against bracket 10. Shaft 12 starts rotating, shearing locking screw 14. Being released, supports 7 turn under the action of spring 15 and are locked by stop pins 22 entering the hole of brackets 21 carrying the supports.

After ejection, the separation of the canopy from the seat is effected by levers 2 which are turned by 215Ф firing mechanisms 16. At the beginning of their travel, levers 2 press the release levers (Fig.230) and open the front grip locks. Simultaneously, the rod of the drogue parachute is thrown off. On their further movement, levers 2 press the stops of the canopy rear grip locks and turn the canopy on the trunnion pins of the seat. When the canopy turns through approximately 110° - 120°, the pawls of the rear grip locks come to rest against the bosses of the seat trunnion pins and release the locks. In this way, the canopy is separated from the ejection seat.

The 215Ф firing mechanisms are actuated by АД-3У time release mechanism 1 by virtue of drive retaining mechanism 4, transverse shaft 6 and rod 5.

The firing mechanisms 215Ф are described in Book II of the present Technical Manual.

The drive retaining mechanism is a device for keeping shaft 6 from an accidental turning. It consists of bell-crank 18 and lever 17 fitted thereon.

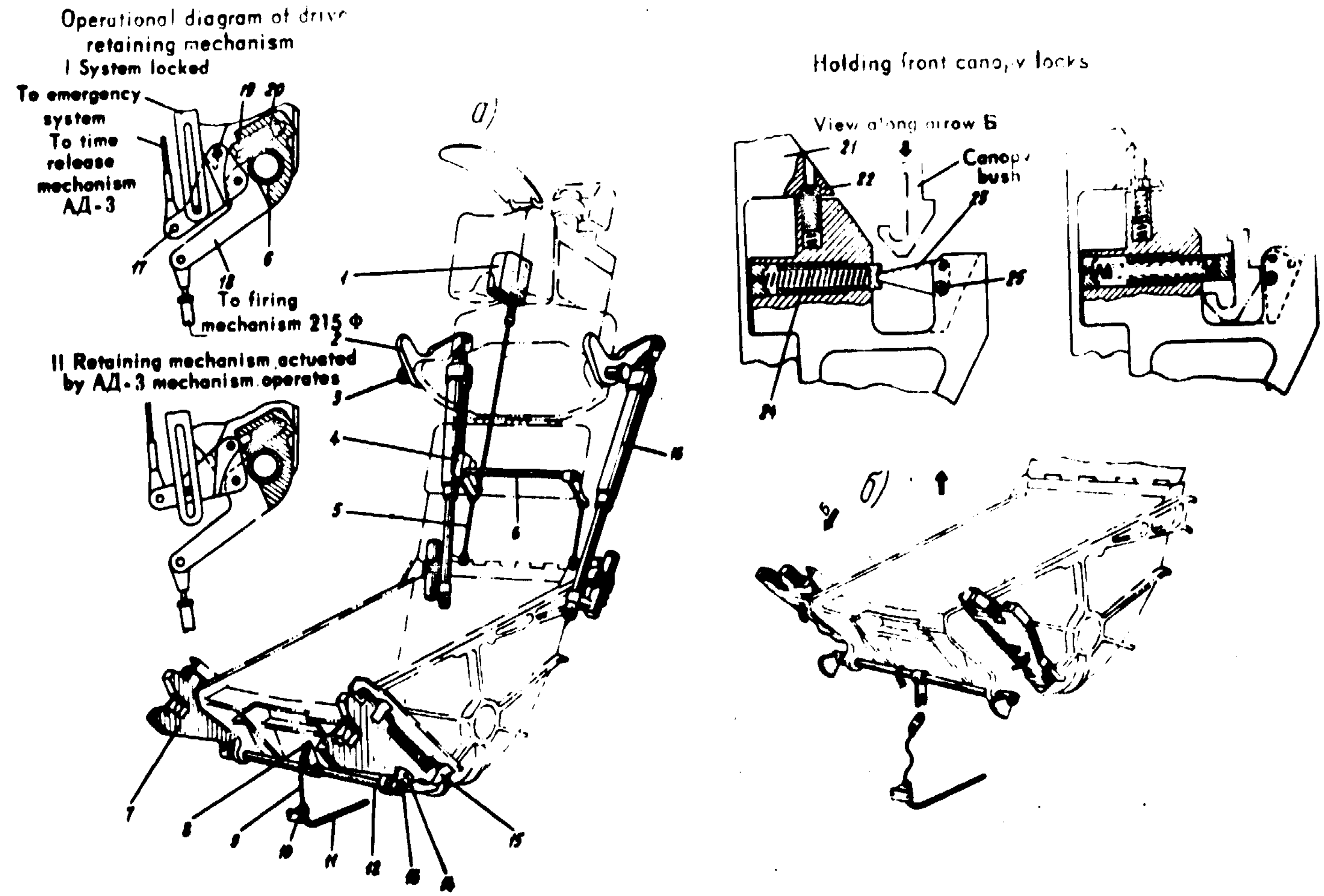

FIG.246. CANOPY HOLDING AND SEPARATION SYSTEM

1 – АД-3У automatic time release mechanism; 2 – canopy separation levers; 3 – trunnion pins; 4 – drive locking mechanism; 5 – rod; 6 – shaft; 7 – hinge support; 8 – bell-crank; 9 – cable; 10 – bracket; 11 – tube; 12 – shaft; 13 – stop; 14 – shear screw; 15 – spring; 16 – 215Ф firing mechanism; 17 – lever; 18 – bell-crank; 19 – pusher; 20 – spring; 21 – bracket; 22 – stop pin; 23 – stop; 24 – pin; 25 – shear screw.

Lever 17 is pressed off by spring 20 through pusher 19 and with its locking pin enters the seat of the body. When the АД-3У mechanism operates, lever 17 deflects, the locking pin leaves the body seat and bell-crank 18 starts turning.

10. Release System for Restraint Locks and Foot-Grips

(Fig.247)

After the canopy has been separated from the seat during the ejection, the restraint locks and foot-grips are released. The opening of the shoulder restraint lock is made by extending locking pin 12. Waist belt restraint locks 6 are released by turning bell-cranks 18.

The foot-grips are opened by turning bell-cranks 3.

The lock release system consists of driving shaft 9, vertical shaft 7 and a set of rods and bell-cranks. When firing mechanisms 215Ф operate, shaft 9 is rotated by canopy separation levers 8 with the help of bell-cranks 13. When turning, levers 8 lie down on bell-cranks 13 and turn shaft 9, pressing them downward.

Bell-crank 14 fitted on vertical shaft 7 is sliding up and down the shaft together with the seat pan, and this ensures a normal operation of the system, with the seat pan being in any position.

The waist restraint lock is designed and operates as follows. Two grips 20 drawn apart by spring 19 are hinged in body 21.

The end of waist restraint lock cable 16 with a bush fitted on it is inserted inside the body and is locked by grips 20 which are retained in the closed position by the protrusions of bell-crank 18. When bell-crank 18 turns, grips 20 and the cables are pulled out of the lock.

To ensure a proper separation of the pilot from the seat, the locks are released in a definite succession.

First the foot-grips are opened, then the shoulder restraint lock, the waist restraint locks being the last to be released.

11. Emergency System for Actuating Firing Mechanisms 215Ф and for Releasing Restraint Locks

(Fig.248)

The emergency system serves to actuate firing mechanisms 215Ф if the АД-3 automatic time release mechanism malfunctions as well as to open the restraint locks and foot-grips when it is necessarily to leave the cockpit on the ground in emergency. The system comprises emergency handle 13, roller 11 with lever 3, spring intensifier 7, and cable linkage 12.

When emergency handle 13 is pulled out, roller 11 and lever 3 are turned and actuate successively firing mechanisms 215Ф, spring intensifier 7, and driving shaft 9 serving as a drive for the lock release system.

The process of releasing the restraint locks is, in this case, similar to that described in Section "Release System for Restraint Locks and Foot-Grips". The only difference is in the way driving shaft 9 is turned.

Spring intensifier 7 consists of a body which accommodates spring-loaded sliding rod 6. When cocked, the rod is retained by stop 5.

When roller 11 with lever 3 starts rotating, stop 5 is turned by bell-crank 4 and releases rod 6 which rests against lever 8 fitted on shaft 9 and helps turn the latter.

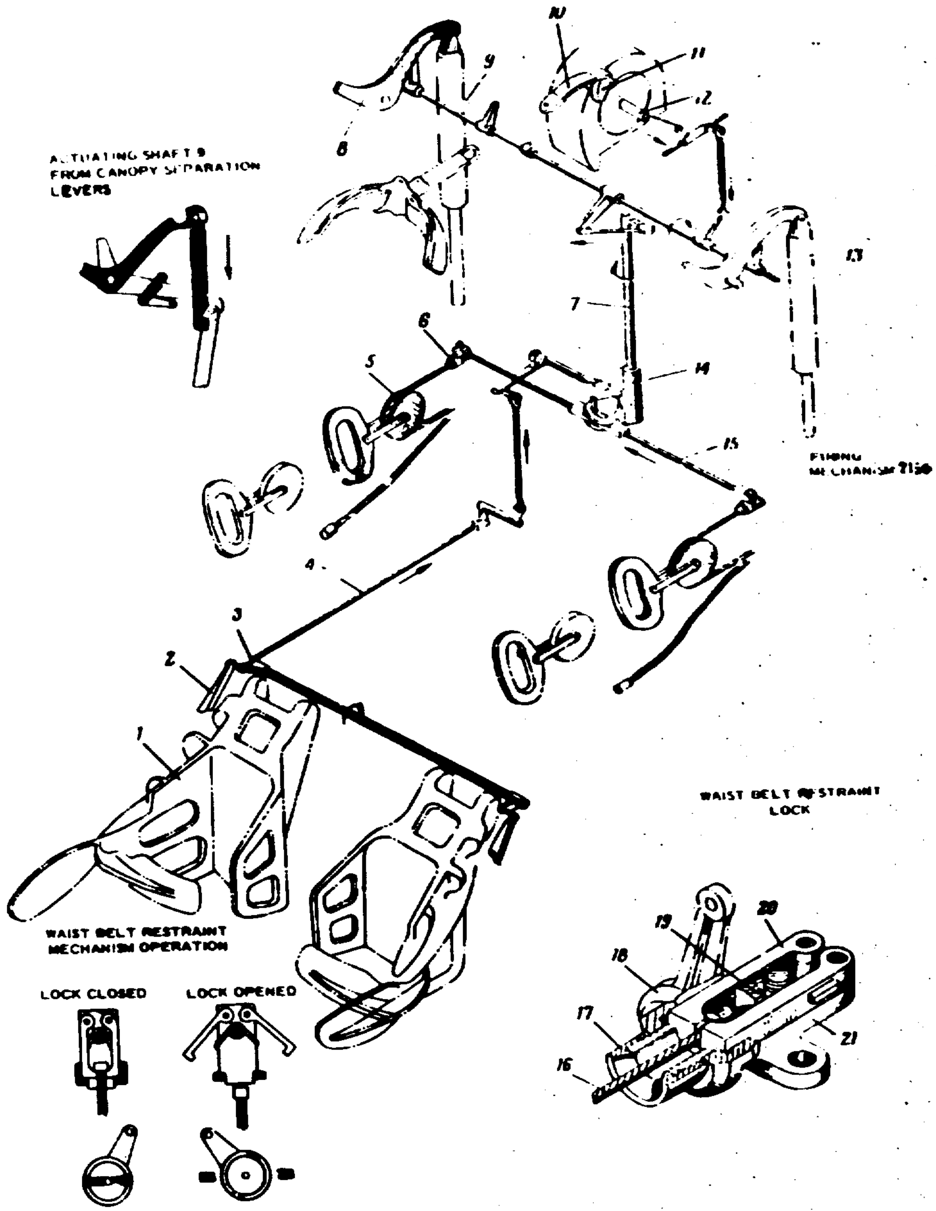

FIG.247. RELEASE SYSTEM FOR RESTRAINT LOCKS AND FOOT-GRIPS

1 – foot-rest; 2 – lever for opening foot-grips; 3 – bell-crank; 4 – rod; 5 – pulley with buckle, 6 – waist belt restraint lock; 7 – vertical shaft; 8 – levers for canopy separation; 9 – driving shaft; 10 – shoulder belt restraint mechanism strap; 11 – hinge support; 12 – locking rod. 13 – release system drive bell-crank, 14 – sliding bell-crank; 15 – release rod for waist belt restraint lock; 16 – waist belt restraint mechanism cable; 17 – nut; 18 – bell-crank; 19 – spring; 20 – grip; 21 – body.

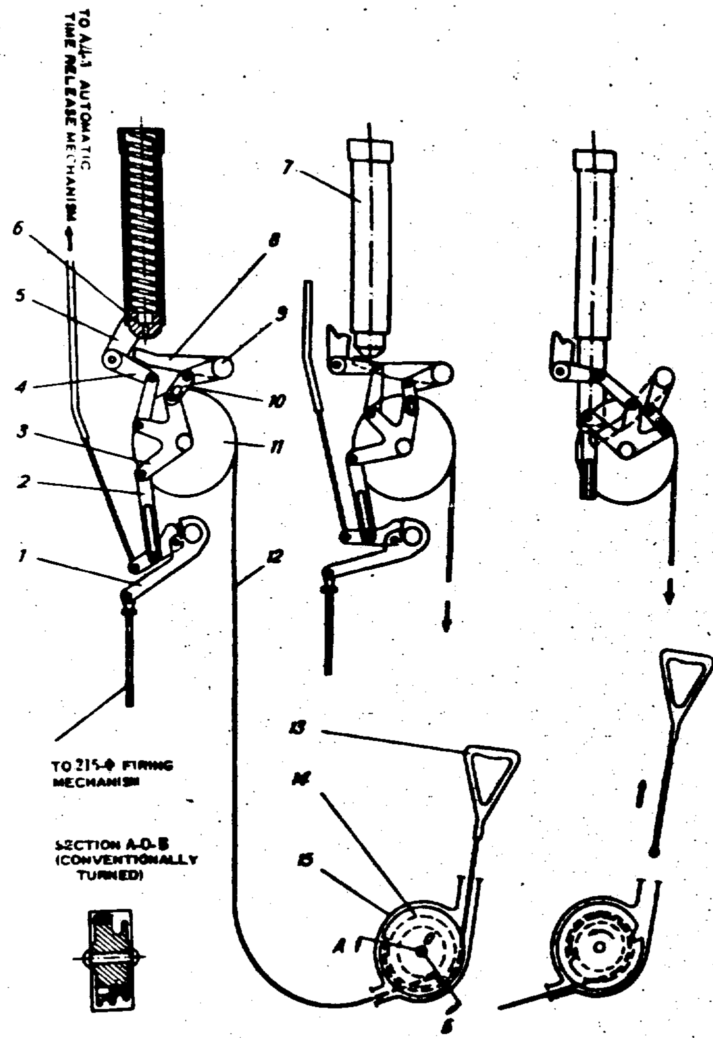

FIG. 240. EMERGENCY SYSTEM FOR ACTUATING 215Ф FIRING MECHANISM AND FOR RELEASING RESTRAINT LOCKS

1 – locking drive mechanism; 2 – shackle; 3 – three-arm lever; 4 – bell-crank; 5 – [illegible]; 6 – rod; 7 – spring [illegible]; 8 – lever; 9 – [illegible] lock release system driving shaft; 10 – shackle; 11 – roller; 12 – cable; 13 – emergency handle; 14 – roller; 15 – body.

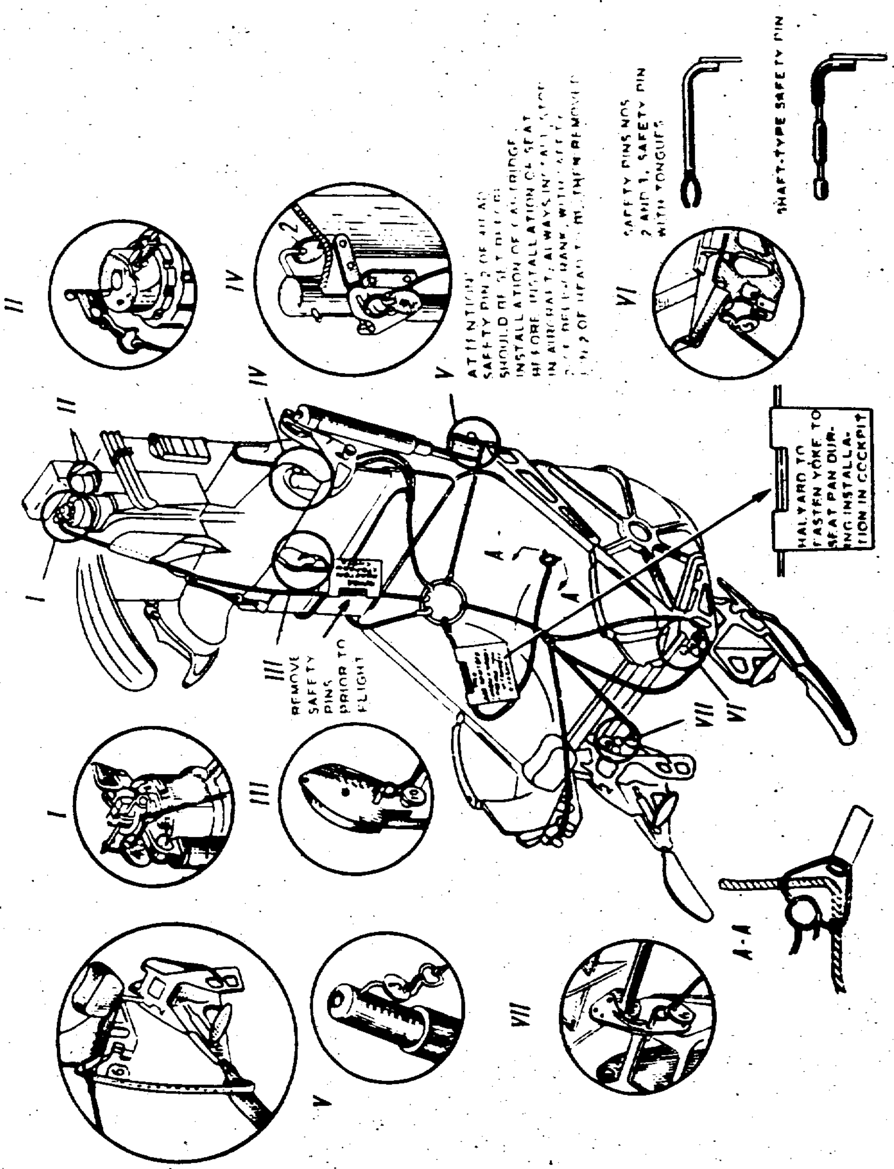

FIG. 249. GROUND LOCKING SYSTEM

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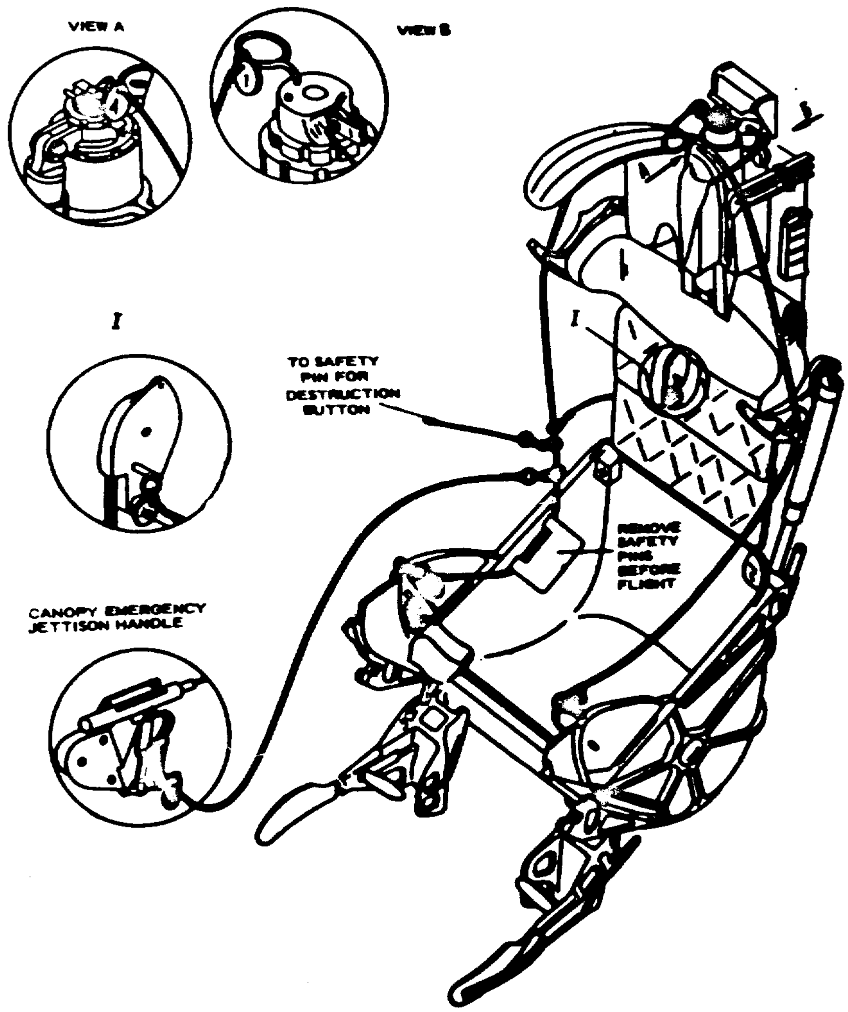

FIG.238. OPERATING LOCKING SYSTEM

25X1

Handle 13 is connected to cable linkage [illegible] by means of roller 14 mounted in body 15. After the locks have been released, handle 13 is pulled out of the roller and remains in the pilot's hand.

12. Locking System

(Figs 249, 250)

To prevent an accidental operation of the ejection seat mechanisms, there are two locking systems: the operating system used to lock the seat mechanisms in the cockpit and the ground system used when the seat is removed from the cockpit.

The operating locking system locks the units in the following succession:

- ejection gun TCM-2500-38 .... (safety pin No.1) (1 piece)
- firing mechanism 215П .... (safety pin No.4) (1 piece)
- handgrips .... (safety pin No.7) (2 pieces)
- canopy jettison handle .... (safety pin No.8) (1 piece)
- protective covers .... (safety pin No.9) (2 pieces)
- 215Ф firing mechanism lock .... (safety pin No.10) (1 piece)

The ground locking system is used to lock the units in the following succession:

- ejection gun TCM-2500-38 .... (safety pin, no number) (1 piece)
- firing mechanism 215P .... (safety pin No.2) (2 pieces)
- firing mechanism 215Ф .... (safety pin No.3) (2 pieces)
- firing mechanism 215П .... (safety pin No.4) (1 piece)
- hinge supports .... (safety pin No.5) (2 pieces)
- foot-rests in upper position .... (safety pin No.6) (2 pieces)
- 215Ф firing mechanism lock .... (safety pin No.10) (1 piece)

For the sake of convenience, the identical numbers are stamped on the safety pins and on the units to be locked; these numbers determine the succession of application of each of the above safety pins.

Fig. 250 presents the numbers indicating the places of locking in compliance with the marking of safety pins.

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